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VOL. VII, PART II QUARTERLY *APRIL*, 1912

THE AGRICULTURAL JOURNAL OF INDIA

AGRICULTURAL RESEARCH INSTITUTE, PUSA

PUBLISHED FOR
THE IMPERIAL DEPARTMENT OF AGRICULTURE IN INDIA

THACKER, SPINK & CO., CALCUTTA
THACKER & CO., 2, CREED LANE, LONDON

CALCUTTA:
PRINTED BY THACKER, SPINK AND CO.

CONTENTS.

MIMOSA PUDICA IN COORG.

By C. A. BARBER, Sc.D., F.L.S.,

Economic Botanist to the Government of Madras.

MIMOSA PUDICA, the sensitive plant, is a handsome weed, with finely divided leaves, of a delicate green colour when fresh and young, turning brownish or reddish with age. The flowers are borne in small round pink heads and the fruits resulting therefrom are in clusters of pods, each of which has a number of little hooks upon its edges. The most striking character of the plant is that, when touched, the leaves at once close up their leaflets and become depressed. This has caused it to be called "humble plant" in America, while its apparent "acting" has earned for it the name of mimic or actor, and hence Mimosa. When the leaves are thus depressed, it is soon seen that, under the feathery green, both the stems and leafstalks are heavily armed with sharp thorns and the general appearance of the plant is completely changed. Thus, on walking through a field of sensitive plant, a broad track is left behind of a darker colour. The leaves open again in a couple of hours as if nothing had happened to disturb them. This brief description will suffice for those whose attention has not been drawn to the plant.

2. It is a native of Brazil and probably other parts of South America. Darwin in his "Voyage Round the World" speaks of the lanes round Rio as being covered with it, and the marks left upon the plants as cattle passed through. It is now widely distributed over all warm countries. It is common in the West Indies and in most of the tropical islands. In Ceylon it has long been known and is described as one of the most troublesome of weeds. It is abundant in parts of Assam and has been credited with causing ulcers on the coolies' legs. It has spread freely in parts of the

Wynaad and is at home everywhere at the foot of the Western Ghauts. From the many vernacular names given to it in various parts of India it would appear to have entered the country a long time ago.

3. The sensitive plant has now, however, aroused the suspicion of the Coorg Government, and I was deputed to make a tour of observation. The following notes as to its distribution were made on a journey from Coimbatore, through Tellicherry, to Sidapur. It was first seen on the side of the railway near Olivakkot, and was thereafter noted as abundant in all sunny and well-drained places, thriving especially on the banks of laterite but entirely absent where the soil was very sandy. Along the coast it was rarely seen, although here and there it covered small areas. At Tellicherry it was rare and, on riding towards the ghauts, it was not met with in the dense, shaded, pepper-growing region. About 5 miles out it was seen in sunny places, and increased gradually as the cultivation showed an upland character, sometimes forming a close, dense cover over neglected dry paddy fields. At Irrity Bridge it was very abundant and luxuriant, covering open places with a dense mass and sometimes climbing over the wayside vegetation for three or four feet. Nearer the foot of the hills there were roadside banks where, for hundreds of yards, it formed a sort of hedge, four feet across and high, pruned to an even rounded surface by the sun, clothed with its delicate foliage and covered with its masses of pink flower heads. After this, as the vegetation increased in luxuriance, it gradually became less frequent, until on the ghauts it entirely disappeared. It was also absent on the grass land above Wattekolli and was only once seen on the way to Virajpet. Beyond Amutti it again appeared, but not in anything like the quantity below ghaut. Along the coffee plantations it was seen here and there on the roadside in sunny parts and was present to some extent in the open space before the circuit-house at Pollibetta. It was finally met with in great force at Sidapur where some 20 acres of orange grove near the circuit-house were covered with one dense mass of it to the exclusion of all other vegetation.

PLATE XI.

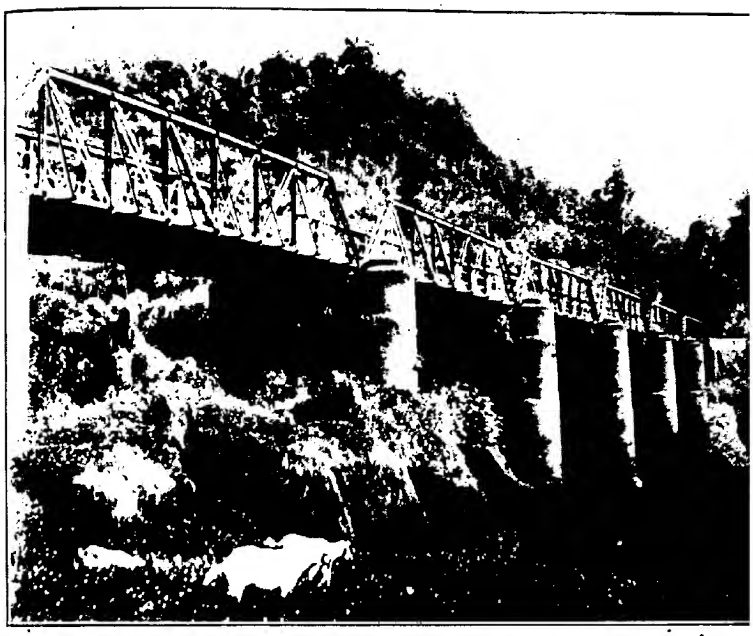


PLATE XII.

Mimosa and Lantana, Sibpur Road.

4. From these observations we learn something of the natural requirements of the plant. It is at home in warm and warm temperate regions ; likes plenty of sun with a sufficiency of rain, requires well-drained soil, and is especially abundant on sloping banks or where there are unevennesses in the ground ; at the same time it will cover with a uniform sheet well-drained or sloping ground where there is free access of light and air ; it is absent in sandy soils and is less abundant where the soil is rich and other vegetation can readily smother it, while under tall shade it grows poorly or is entirely absent. Its typical home is the roadside, and indeed it is reported from the Federated Malay States to be the first weed which takes up and keeps the sides of newly-opened roads.

5. It is an annual in the United States, but probably becomes perennial in the tropics. It forms long branches which either scramble over other low plants or, lying on the ground, root at every node. Its rooting power makes it easy to propagate by cuttings, and this has been done in rubber plantations in the Malay States. The root system is well developed and the plant is able to withstand a moderate degree of drought, although it does not grow freely then and becomes very hairy. It has been found difficult to grow it at Coimbatore for class work. The roots are well covered with nitrogenous nodules and, but for its thorns, the plant would be a most valuable aid as a ground cover in open estates. It seeds very abundantly, almost every leaf axil bearing one or two heads of flowers, which in due course become a mass of incurved seed pods. The latter are prickly and split up readily into separate segments, each containing one seed, and these mericarps adhere easily to passing bodies, such as the feet of cattle, and this ready means of dispersal seems to account for the sudden appearance of the plant in numbers at widely separated places. I have calculated that a good head of fruits may contain 150 seeds and that a good-sized plant may at one and the same time bear as many as 10,000 seeds, in various stages of ripeness. The sensitive plant in the orange grove at Sidapur was at the time of my visit full of fruit and this area

alone would amply suffice to stock the whole of Coorg. It is on a main road where the traffic is heavy and is regularly grazed by a large herd of cattle. The plant is peculiarly free from insect and fungoid attacks and the seeds have been known to keep good for over 60 years, and may thus lie in the soil for a considerable period. These facts—together with its own special peculiarity, undoubtedly a protection from mechanical injury and grazing animals—indicate that we have to do with a highly specialized plant, fully able to take care of itself, and the question of fighting it becomes a very difficult one. We have, however, learnt that it has certain needs, and also that there are certain natural barriers which prevent its spread. The extra-luxuriant vegetation on the ghaut is the first great barrier to be noted: it should not therefore be a danger to the local forests. Its partiality to sunny places will render its entrance to coffee estates or other shady "totes" unlikely. On the other hand, it promises to be troublesome in all open cultivation such as orange and rubber plantations. It need not be feared in the cultivation of the plains because of its need for abundant moisture: and it does not seem to relish sandy soil. This latter is probably due in part to the dryness of such land, for it is not unusual for plants freely supplied with nitrogen-producing nodules to take up sandy land. Such is the case with the ground nut, the wild indigo (*Tephrosia purpurea*) and Casuarina trees, which latter will grow in almost pure sand because of the immense number of large, massed nodules on their roots.

6. As to its economic value there is much to be said for it. As has been pointed out by the scientific officers in the Federated Malay States, it is very well provided with nodules and is an excellent cover for the ground in that it closes its leaves in cloudy weather and at night, and thus exposes the ground to dew and rain, while during bright light it protects the ground from the heat of the sun. It should form a very useful rotation with hill paddy, for it will be easily removed in preparing the land before sowing and will cover the ground during the rest of the year. On examining the neglected orange and pepper tote at Sidapur it seemed probable that it has had a very salutary effect on the

trees. The pepper vines are very strong and healthy, while the flush of green leaves on the orange trees is very marked, and shows that they are doing well. As to its fodder value, the owner of the plantation has informed me that his cattle eat it freely and have done so for the past two years without any ill effect. I observed them feeding while I was at work and have also noted goats daintily choosing the tender shoots and preferring them to grass. In these characters the plant seems to be rather useful than otherwise. It is reported from the States that it is injurious to cattle because the thorns are harmful internally and that sheep suffer from ulcers in their feet because the prickly fruits get in between their toes. I do not see any reason for supposing that this is the case in Coorg. The cattle are reported to be quite healthy, and there are so many worse thorns in the tropics that the statement about the sheep seems to require verification. The same remark applies to the imputed ulcers on the coolies' legs in Assam. All the same, the presence of hard, sharp thorns is a sufficient counterpoise to all its good qualities, especially in a country where the natives' feet and legs are uncovered. It is an interesting fact that the three most undesirable plants in India are thorny and, but for this fact, the Lantana, sensitive plant and prickly pear might no doubt be welcomed in the fields. They all, in their way, form excellent cover for the ground, one of the great needs in all tropical agriculture.

7. Having once classed *Mimosa pudica* as a noxious weed, we must now consider what chances there are of exterminating it. And this question is far more difficult than would appear at first sight. Before detailing the various means of eradication which have occurred to me, it will be well to refer to other similar cases, as well as the general question of the balance of nature. We are, it may be stated at the outset, in entire ignorance why exactly a plant, usually growing scattered, will, when in new surroundings, sometimes cover the ground so as to become a pest. What are rightly regarded as noxious weeds in one place are frequently of no account in what appear to be the exactly

similar conditions of another. Two or three Scotch thistles have been noted as covering completely hundreds of square miles on the South American pampas, smothering all vegetation and even hiding a man riding on horseback. The white clover has spread over almost all temperate regions, in some places completely ousting the indigenous weeds over large tracts. A small red sorrel, common at home, has clothed whole landscapes in New Zealand with a sheet of red to the exclusion of all other vegetation. A small Composite, imported with grass seeds from England, has become such a pest in New Zealand that, once appearing in a locality, it has destroyed the natural grasses in three years. In these cases the balance of nature seems to have been hopelessly disturbed. But there are also cases which would give us some hope. The Lantana which was formerly regarded as a pestilential weed in the Federated Malay States is not now regarded as such, having largely disappeared. The same curiously is said to be true of the sensitive plant which has quite disappeared from parts of the Malay States where it was formerly abundant. A very troublesome pest in New Zealand, called the "Cape Weed," was voted by Baron von Hugel in 1833 as "an inexterminable pest," but it has now given place to lucerne and grasses.

8. These few facts have been mentioned to show that there is possible hope in this direction, namely, of nature's ultimately adjusting matters so that no plant occupies more than its fair share of the land. (1) And they suggest the first method of fighting the sensitive plant, that of *waiting*. It is of course the most scientific plan that can be adopted, but it is slow. At the same time, it must be held in mind that the more rapid and drastic methods of so-called eradication usually adopted may in actual fact hinder nature's adjustment and thus greatly prolong the time during which a plant may be regarded as a pest. (2) A rather more promising plan will be to attempt directly to interfere with the balance of nature by *introducing some less feared plant* which will drive out the invading weed. It is true that attempts of this kind are rarely successful. Cases are on

record where desirable weeds have been sown for many years continuously in new localities having similar climates to their own without any practical result, while, in others, the casual introduction of some new plant by an accident has led it to take hold of vast stretches of land in spite of strenuous opposition. An interesting and successful case is that of the watercress in New Zealand. After its introduction it rapidly became a pest in that it choked up the rivers so as to prevent navigation. It was, however, noted that the water roots of willows interfered with its growth, and the planting of willows along the banks of the streams was completely successful and did away with the expensive eradication work. One small stretch of river had previously cost £300 a year to clear. Lalang (Imperata sp.) is perhaps the most difficult of all pests to deal with because of its hardy habit and long underground shoots, but it is said to be smothered by a creeping passion flower.

The usual position of the sensitive plant in Coorg is on the roadside, with Lantana beyond and the forest behind. What other plants grow successfully in similar positions? Observations made on this point are of course only preliminary and the weeds now mentioned are merely such as were seen during my short visit, but I mention them in order to encourage observations on the part of residents in Coorg. *Stachytarpheta indica* seems able to occupy the ground fully in the midst of Mimosa patches, but it is doubtful whether it is a desirable weed itself. Its home would appear to be in hotter, drier places than Coorg. *Cassia tora* sometimes seems able to hold its own, but here, again, the weed is useless for grazing and is not liked. *Cassia hirsuta* is abundant in some places (Pollibetta) and is used as a ground coverer in some estates, but it grows rather tall and does not cover the ground very well. *Sida carpinifolia* is common in situations suited to *Mimosa pudica*. It is a small wiry bush with good fibre but of no use as a fodder plant. *Ageratum conyzoides* has many small seeds and comes up in enormous quantities where the scrub has been burnt. It is abundant on waste coffee land and should be a useful smotherer. The same may be

said of the Spanish needle (*Bidens* sp.) and the large rose-flowered *Cosmos* so abundant around Pollibetta. *Desmodium triflorum* is a small creeping clover-like plant which forms a close mat with the local grass. It is worth considering as a rival of Mimosa, for it has been noted as eagerly taking up the fresh earth where Mimosa has been dug out. *Passiflora fœtida* itself might be tried, as it would probably grow over the top of the Mimosa and might smother it as it is said to do Lalang. Seeds were collected during my stay of Sida, Ageratum, Bidens, Cosmos, and Leucas and these were sown in the cleared plots at Sidapur and Pollibetta. The result will be of interest in some months' time, but nothing can be said of the success or otherwise of this line of work without far more careful and extended study of the local conditions. Observations are therefore called for on the subject, and especially if any plant can anywhere be credited with replacing the sensitive plant in the area. I have made a note, for instance, that in the orange plantation at Sidapur where several pepper vines have been cut down, numerous suckers are appearing from the underground runners. In such places while the grass is growing freely, there are no sensitive plants, although there are masses all around.

(3) The many valuable properties of the sensitive plant would lead us to hope for the *production of a thornless variety*. This has been looked for in the Straits, but I have no knowledge with what result. I have heard it confidently affirmed that there is such a variety in the Fiji Islands and that it is used as a ground cover, but I have had no means of ascertaining if this is a fact. If it is found, it will be well worth propagating as well as crossing with the local variety. Thorniness is usually more pronounced in dry situations, and the plants below ghaut seem to be less troublesome in this respect than in Coorg. As this is probably a simple Mendelian character, it might be worth while trying a cross with a thornless Mimosa of the same section. But here we receive no help from the Indian forms. They are mostly shrubs or large climbers and heavily armed. In Brazil, however, where the bulk of the Mimosas occur, there are many which are

thornless and it should not be impossible to obtain seed of one of the unarmed varieties closely allied to *Mimosa pudica*. Experiments on these lines cannot, of course, be carried out without plenty of time and a properly equipped staff.

(4) The *actual destruction* of the sensitive plant is not difficult. And were it not for its extraordinary seeding powers, the whole thing might be rapidly and safely carried through. Any form of destruction must, however, be repeated at intervals because of the enormous mass of seeds in the ground, which germinate at the least encouragement. This has been noted wherever attempts have been made to clear the Mimosa, as well as in the road from Irrity Bridge to Irrukur.

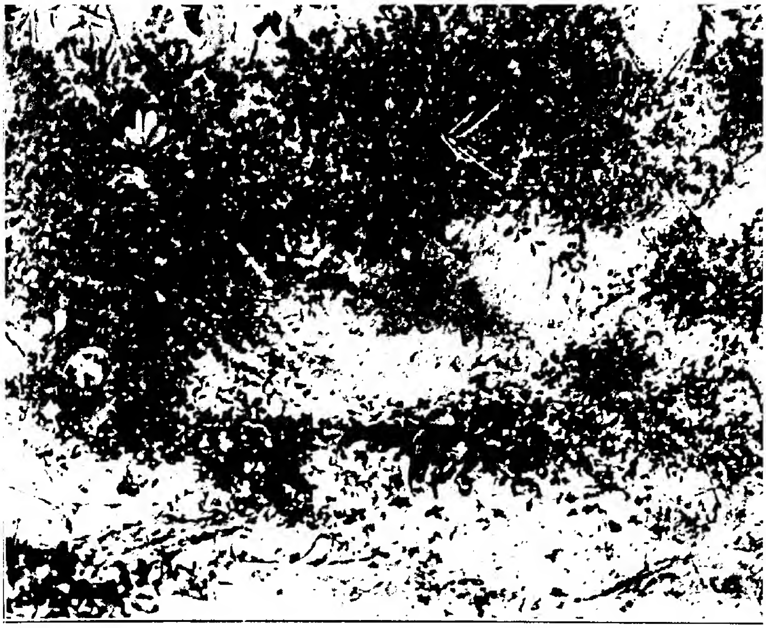
In the densely covered orange plantation at Sidapur I have tried the use of mamuties for *scraping the ground clear*, sickles for cutting the stalks off short, and the ordinary flat piece of iron used in the low country for clearing grass lawns, called "swords." Of these the mamutie appears to be considerably the quickest and cheapest. The stalks are tough and difficult to cut. The cost of scraping was found to be about Rs. 12 per acre. After such work the "roots" will shoot again and the countless seeds in the soil will germinate. Digging out the whole plant seems to be unprofitable. I have noticed that the ground thus freshly turned over has soon been invaded by a very large number of seedlings which eagerly take hold of the fresh earth and that, in almost all cases, the work has been inefficiently done and some of the old shoots have sprouted again. As will be seen below, the success of the method of scraping the ground with the mamutie will depend upon the time when it is done, and this cannot be determined without a clearer knowledge of the life-history of the plant.

(5) *Destruction by a weed killer.* Experiments were made with sodium arsenite sprayed from a knapsack sprayer. The above-ground parts withered up quickly enough, but I could not stay long enough to see the effect on the underground parts. The strength used was one in sixteen and the cost per acre of material came to about Rs. 8. It is quite possible that a weaker solution

may be as effective, but I used the strength which had been proved elsewhere to be most effective on general surface vegetation. The work was slowly done and needed two coolies. In other countries one man is found sufficient, but I do not think that this will be so in India. It is possible with densely covered ground to do an acre a day, but, where the plants are scattered, both the material and the labour will cover a much greater area. The best time for spraying would appear to be fine sunny weather with good dews at night. It is useless to attempt it during high winds or in the rainy season.

(6) Of all the methods, that of *destruction by fire* would appear to be the most effective but, for various reasons, it could be rarely safely carried out. Two facts may, however, be noted. Fire seems to destroy the parts left in the ground after scraping or sickling, and wherever the Mimosa heaps had been burnt after cutting, there appeared a surprising number of seedlings. The fire, in fact, while it appears to destroy the underground parts, seems to have a stimulating effect on germination of the seeds. This is of course desirable, for if all the seeds can be induced to germinate in one season, the subsequent work will be greatly diminished. I found that after scraping in good hot sun, it was quite easy to burn the trash within a few hours, in fact, on the same day. It might be possible in drier periods of the year to burn the whole *in situ*, and if the Mimosa will not readily burn, a few branches of Lantana laid on top would probably suffice. But the method will have to be very cautiously worked in Coorg because of forest fires.

9. All these experiments will however depend upon the life-history of the plant. Although a certain number of observations have been made, there are other facts which should be determined before concerted action could be wisely undertaken. It is important, in the first place, to learn whether there are any definite seeding and flowering periods. From the plants observed in Coorg it appears probable that, while flowering and fruiting all the year round, the plant will grow more luxuriantly and flower more profusely in the wetter weather, while the flowering



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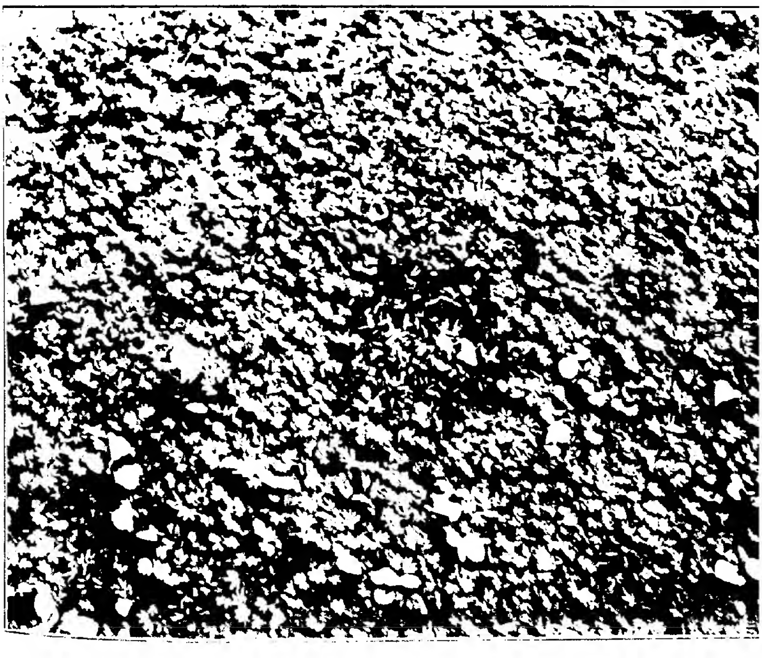


SEEDLINGS SPRINGING UP WHERE THE TRASH WAS HEAPED AND BURNT. [illegible]

will largely cease and the seeds mature better in the dry times of the year. Many plants that I saw at the time of my visit (end of October) had completely ceased growing and were full of ripening and ripe fruits. The seeds will, in the same way, probably lie dormant during the hot dry weather and germinate in masses as soon as the soil becomes moist. The facts should however be determined with full regard to the usual periods of rain and drought. It might be dangerous, for instance, to conduct extensive measures at the present moment when the plants are full of ripe seed. Unless managed with extreme care, the result will only be to render the plant a very great assistance in the matter of dispersal by seed. The correct time of action can only be determined after obtaining a better knowledge of the life cycle of the sensitive plant in Coorg. In any case there will have to be two operations, one for the destruction of the growing plants and the other for the seedlings which will spring up to take their place. And as determining the length of time between the two operations we should, in the first place, learn (1) how long it takes for the seedling to grow into a mature plant with ripened seed and (2) how long it takes for a flower to change into a set of mature pods. These observations can only be made by those on the spot and should not be a difficult piece of work.

10. I made two halts in Coorg, one at Pollibetta and the other at Sidapur, and the following experiments were tried as a preliminary step towards finding out the best method of dealing with the pest.

At Pollibetta the open space in front of the circuit-house shows signs of an invasion by the weed. It had been treated about a month before my arrival and this fact enabled me to make some useful observations. Where the plants had been dug out, there were nearly always new healthy shoots springing from the old roots and the freshly turned up soil was full of seedlings. *Desmodium triflorum* was however making a bid for the unoccupied space and certain other weeds were also coming up. Where the Mimosa had been cut by sickle, there was a close cover

of new shoots, and where the trash had been burnt, the Mimosa roots were dead and all around an enormous mass of seedlings had appeared. In places, *Ageratum* was also coming up very thickly, while *Cassia tora* and especially *Sida* seedlings were much in evidence.

Two experiments were tried on the ground which had thus been treated by cutting and burning the trash.

(1) Spraying with sodium arsenite. Two patches each about 1,800 square feet were treated. Most of the plants withered quickly, but some were not dead when I left the place. These had, however, received a severe shock and, although the leaves were expanded, they had lost their sensitiveness.

(2) Digging the ground. Two plots were thus dealt with, care being taken to invert the sods. This experiment was not intended as a demonstration of a practical method, but rather to learn more about the recuperative powers of the plant. Half of the dug area was left as it was and half was sown with a mixture of seeds of *Bidens*, *Cosmos*, *Sida* and *Ageratum*.

11. At Sidapur the area chosen was the orange grove owned by M. R. Ry. Bidaya who kindly rendered me assistance with coolies and allowed me a free hand. The ground was completely covered by a dense growth of Mimosa about a foot high. There were very few flowers and the young shoots had evidently been constantly grazed by cattle. The whole mass of plants were in full seed and, spreading in all directions, were intertwined and rooted at intervals. Six plots were marked out parallel to the main road, each being 2,500 square feet or $\frac{1}{16}$th of an acre. They were treated in the following manner :—

(1) Scraped with the mamutie, the trash collected into two heaps and burnt.

(2) Sprayed with sodium arsenite and left as it was.

(3) Scraped with mamutie, the trash arranged in heaps and the bare ground sown with a mixture of weed seeds (*Ageratum*, *Sida*, *Bidens*, *Cosmos* and *Leucas*).

(4) Sprayed with sodium arsenite and left as it was.

(5) Scraped with mamutie, the trash collected into two heaps and burnt, and the ground sown with the mixture of weed seeds after being lightly stirred (because of the absence of rain and the hot sun).

(6) Scraped with mamutie and left as it was.

Possible variants of these methods may be suggested as follows :

(*a*) Scraped with mamutie and burnt without collecting into heaps. This might prove useful in destroying the "roots."

(*b*) Spraying and, after a couple of days, burning *in situ*. The dried-up Mimosa plants burn very rapidly.

(*c*) Burning in dry weather. Care would of course have to be taken to make fire protection rings round the trees and round the whole plantation, but this would not be difficult.

(*d*) Sowing with Lantana. It seems probable that Lantana has a stronger growth than Mimosa and is more easily eradicated. It would in any case be interesting to note the relative strength of growth in these two.

12. The eradication of *Mimosa pudica* from the orange grove at Sidapur would appear to be necessary because of the danger of this area spreading Mimosa over all the roadsides in Coorg. The treatment of such an area would be comparatively easy. Eradication of scattered plants along the roads and banks where the Mimosa adjoins Lantana and forest would be much more difficult. Firing would be out of the question and the greatest care would have to be exercised not to carry plants from place to place, but to destroy them *in situ*. From the peculiar character of the pod, which breaks into separate small joints at the least pressure or even if left untouched, and the very great number of seeds borne by each plant, any work not very carefully superintended will inevitably spread the plant more widely. And, considering this difficulty, the spraying experiments should be closely watched. The method is not expensive, and should be much less so in dealing with scattered plants than in a dense mass. There is no spreading of the seed and all the green parts of the plant are destroyed : it is possible that the roots may also be killed. A

second operation, when the seedlings of the next germination are well grown but have not produced ripe seed should complete the work. The materials may be obtained fairly cheaply in Madras bazars. We pay 1½ annas per lb. for the soda and 8 annas per lb. for the white arsenic, but if obtained in large quantities direct from England, there should be a considerable reduction. Complete spraying of the ground costs about Rs. 8 in material, but, with scattered plants, it would of course be less. Full details and instructions may be obtained concerning the work at any time from my office. It is quite probable furthermore that with a longer series of experiments, the strength of the solution may be lessened and thus a further reduction in cost be realised.

THE ANTIGUA CENTRAL SUGAR FACTORY.

By G. N. SAHASRABUDHE, L. Ag.

The history and development of this factory have a peculiar interest from several points of view. This is the pioneer central factory in the Leeward Islands. Though the sugar industry is the backbone of these islands, and though this industry had been successfully carried on for about two centuries, yet, till the end of the last century, nobody thought of introducing modern methods of sugar manufacture in these islands. While a great evolution was taking place in the process of sugar manufacture, and countries like Java, Mauritius, Egypt, Louisiana, Hawaii, Trinidad and Demerara were competing to install the most up-to-date machinery available, the planters in the Leeward Islands were content with their windmills, copper walls and draining boxes. But the last quarter of the 19th century made it abundantly clear that things could not go on in this way any longer. At last a period arrived when the sugar industry of these islands was on the verge of ruin. Everybody was taken aback by the situation, a cry was raised for help, and accordingly a Royal Commission was appointed, in 1897, to investigate the reasons of the downfall of the sugar industry in the West Indies. As a result of this investigation the immediate cause of the catastrophe was found out, with the result that the Brussels Sugar Convention put an end to the sugar bounties in Europe. But at the same time it was realised that the abolition of bounties would only give immediate relief and would not be an everlasting cure. Suppression of bounties gave a steady market, but by this time

the process of sugar manufacture had been revolutionized to such an extent that conducting the industry on the old lines meant anything but a remunerative return. But at that time many of the sugar estates in the Leeward Islands were on the verge of bankruptcy, while others were making but a precarious living. In this state of affairs investment of large amounts of capital for starting modern sugar factories was risky, and, though Dr. Watts had been preaching the gospel of central sugar factories ever since 1894, his words remained a cry in the wilderness for a good many years to come.

In 1901 a serious effort was made to start a central factory in Antigua, but though the scheme was given the warmest support by Sir Henry M. Jackson, the then Governor of these islands, and though at first it bade fair to come to fruition, ultimately it fell through. Another attempt was made in 1903. The chief trouble up to this time had been in inducing the capitalists to invest money in such an undertaking. In order to attract capital, Sir Gerald Strickland, the Governor, proposed to offer a bonus of £15,000. On the recommendation of the Royal Commission of 1897 a grant of £250,000 had been sanctioned to help the West Indian sugar planters. A portion of this sum had been left unspent, and Sir Gerald Strickland proposed to offer it as a bonus to any group or company who would undertake to erect and work a modern central sugar factory in Antigua. This was a strong inducement, yet the position of the sugar industry was considered to be so insecure that it was only after a good deal of negotiation and anxious hard work that a company came forward to accept this undertaking. Eventually a contract was signed between the Government and the firm of Messrs. Henckell DuBuisson & Co. for the equipment of the Antigua Central Sugar Factory, by virtue of which the Company was to get the bonus of £15,000, on the condition that it started a factory with a capacity of not less than 30 tons of grey crystal sugar per 23 hours, and purchased 75,000 tons of peasant's cane in 15 years, at a price equivalent to not less than 4½ lbs. of grey crystal sugar per 100 lbs. of cane. The head office of the

Company was in London, and the capital stock was made up as follows:—

12,500 "A" shares of 1*s.* each.
250 "A" Debentures of £100 each.
12,500 "B" shares at 1*s.* each.
15 "B" Debentures of £1,000 each.

The "A" and "B" shares are not actually paid up, but represent the Debenture stock, *i.e.*, the 250 "A" debenture holders, who floated this Factory Company, have received the 12,500 "A" shares as fully paid up. Similarly, in virtue of the 15 "B" debentures which are held by the Government and which represent the amount of the bonus, 12,500 "B" shares have been allotted to the Government as fully paid up. These "B" shares have been assigned by the Government to a group of estate proprietors who entered into a contract with the factory, when it was started, to keep 1,300 acres under cane, and to deliver the cane to the factory at a rate equivalent to 4½ tons of grey crystal sugar per 100 tons of cane.

The 250 "A" debentures bear a 5 per cent. interest and are to be amortized from the profits by annual instalments in 15 years. The "B" debentures bear no interest and are amortized without payment as soon as the condition about the peasant's canes is fulfilled, one debenture being written off each year provided the factory is worked properly during that year. After paying the interest on the "A" debentures and after setting aside sums for the amortization of the "A" debenture stock and for a reserve fund, the net profits that may be left over are divided equally between the capitalists, who hold the "A" shares, and the original contracting proprietors, who hold the "B" shares. To settle any disputes that may arise and to settle the rate that is to be paid for the peasant's cane a "Central Factories Board" has been appointed.

Besides the cane from the original contracting proprietors and the peasant's cane, the factory also purchases large quantities of cane from the adjoining estates where proprietors have not

entered into any specific contract with the factory. These canes are paid for on the basis of the current net price of 5 tons of grey crystal sugar per 100 tons of cane. For this purpose the average price of a fortnight is taken and the cane delivered during the previous fortnight is paid for at that rate.

Factory Equipment.—When the factory was started in 1905, it had a crushing capacity of 300 tons of cane in 22 hours and consisted of the following machinery :—

Two water tube boilers, two 3-roller mills driven by one engine; two juice heaters: five filter presses: one triple-effect evaporator; two vacuum pans; a central condenser and dry air pump; six crystallizers: five Weston 36″ centrifugals.

In 1906 one 36″ centrifugal and one filter press were added.

In 1907 the capacity of the factory was increased to 400 tons of cane per 22 hours and the following machinery was added :—A Krajewski cane crusher driven by a separate engine; one juice heater; one crystallizer.

In 1908 three 36″ centrifugals were added.

In 1910 the supply of cane had increased to such an extent that it was thought necessary to increase the size of the factory all round and, for the season 1911, the capacity of the factory is 750 tons of cane per 22 hours. Some of the additions still require to be made and therefore this season the factory is not worked to its full capacity. As it at present stands, it consists of the following machinery :—

1. Two cane rakes driven by a vertical engine.

2. The milling plant—consisting of a Krajewski crusher and four 3-roller mills, with rollers 30″ × 60″ with arrangement for maceration.

3. One engine, 18″ × 36″ stroke, driving the Krajewski crusher and the cane elevator, and two engines, 26″ × 48″ stroke, each driving two mills.

4. A megass elevator and cross carrier, driven by an engine which also drives the scum carrier under the filter-presses, and a filter bag washing plant.

5. Four measuring tanks.

6. Four juice heaters, two having 500 sq. feet heating surface each, and two having 600 feet heating surface. Total heating surface 2,200 sq. feet.

7. Twelve rectangular subsiders and three circular eliminators.

8. Eight filter presses, each having 30 leaves, size 2″ × 2″, presenting 240 sq. feet filtering surface. Two scum tanks and two magma pumps, for 100 lb. pressure per sq. inch.

9. Two triple-effect evaporators, each having 4,000 sq. feet heating surface.

10. Three vacuum pans, two having each 450 sq. feet heating surface and a masseeuite capacity of 15 tons. The third is a big Calandria type pan with 150 sq. feet heating surface and a massecuite capacity of 30 tons.

11. Two central condensers of the Toricellian type with dry air pumps, one serving one of the triple effects and the two small vacuum pans and the other serving the big vacuum pan and the second triple effect evaporator. The air ends of the pumps are 24″ in diameter and the steam ends 16″ × 24″ stroke.

12. Seven crystallizers, each having a massecuite capacity of 15 tons.

13. Twelve Weston type, belt-driven centrifugals, having baskets of 36″ diameter, made by Messrs. Pott, Cassels and Williamson, of Motherwell, Scotland. The centrifugals are driven by two engines, each driving 6 centrifugals; they are also fitted with two screw conveyors and two bucket-type sugar-elevators.

14. Electric light plant, consisting of a direct coupled continuous current dynamo, running at 450 revolutions per minute and producing a current of 210 ampères at 105 volts. There are 16 arc lamps and about 100 metal filament lamps, each of 32 candle-power. The arc lamps are being replaced by groups of 4 metal filament lamps on one bracket, giving 400 candle-power light.

15. Three Babcock and Wilcox water-tube boilers, fitted with special megass furnace, working pressure 150 lb., which is

reduced to 100 lb. for the factory, by a reducing valve. Each boiler has 5,764 sq. feet heating surface, one iron chimney, 6 feet internal diameter and 163 feet high and two boiler feed pumps.

16. One mechanic's shop, consisting of four stationary and two portable hearths, two drilling machines, two lathes, one circular saw, one planing machine, and other minor implements, driven by a Tangye steam engine, which also drives the crystallizers. The steam is raised in a vertical boiler burning coal. This boiler also supplies steam to the centrifugal engines when the rest of the factory is not working.

17. Two duplex pumps, one for raising water to the condensing tower, and the other for raising the warm water from the condenser to the cooling tower. The machinery is supplied by Messrs. Mirrlees Watson & Co., of Glasgow.

Railway.—All the cane is brought to the factory by a system of light railway. The length of railway line when the factory was started was 5½ miles. In 1907 it was increased to 9½ miles. In 1909 another 3 miles were added. In the last year a further addition of about 5½ miles has been made and now the mileage stands at about 18. The gauge is 2' 6" with rails 30lb. per yard. The service is kept up by 4 locomotives and 307 trucks. The line is carried through almost all the estates, supplying cane to the factory and is also brought to the wharf in St. John's Harbour.

Buildings.—All the machinery is housed in a huge iron structure made of H-type beams and covered with corrugated iron sheets all round. This main building has been built by Messrs. A. & J. Main & Co. Besides the main building, there are extensive buildings for offices, stores, laboratory, the officers' quarters, and the workmen's quarters. In fact, the surroundings of the factory have the appearance of a small town.

Water-Supply.—The water-supply for the factory is derived from a reservoir made by damming an adjoining valley, and from two springs. But the water-supply is insufficient and unreliable, and occasionally it becomes necessary to get it from the public reservoir at Wallings.

Method of Work.—The trucks holding the cane are brought below the cane rakes, which pull out the cane and drop them on the cane conveyor. The canes are taken by the conveyor to the Krajewski crusher and then passed successively through the different mills. The mills are run at a speed of $2\frac{1}{2}$ revolutions per minute, the engine making 50 revolutions per minute. Maceration water is applied before the fourth mill and the diluted juice obtained from that mill is used again before the third and second mill. The juice is pumped to the measuring tanks where it is limed with lime cream standing at 10° Bé. at the rate of $1\frac{1}{2}$—3 gallons per 800 gallons of juice. The limed juice is forced through juice heaters and then led to the settling tanks. There it is allowed to settle for about 2 hours, the clear juice is decanted by means of a float, and the scum passed to the scum tanks. The clear decanted juice is led to the eliminators where it is brought to the boil, any scum rising to the top is brushed off and the clear juice is pumped to the triple-effect supply tanks. The scum is further limed in the scum tanks, and then forced through the filter presses at a pressure of 100 lb. per sq. inch, and the filtered juice is added to the clear juice in the triple-effect supply tanks. The juice is evaporated in the triple-effect to 30° Bé. and the syrup is pumped to the vacuum pan supply tanks. The syrup is boiled to grain in the big calandria pan with exhaust and direct steam. Usually two cuts are taken. The pan is emptied into the strike mixer below and the first massecuite is centrifugalled hot. The purity of the syrup is usually 88 and that of the first molasses usually 69—70. For the treatment of the molasses the Java process is followed, treating the molasses in two stages. First grain is obtained from the syrup in one of the two small coil pans and then filled up with the first molasses, getting a massecuite of about 63 purity, thus obtaining the green Java strike. This is cured hot, and a molasses of 50 purity is obtained. From this molasses again, a mixed strike is obtained. This is cooled slowly in motion, and then centrifugalled, obtaining an exhausted molasses of 35—40 purity. Only one kind of sugar is made, *viz.*, grey crystal, polarizing about 96°

Chemical Control.—The whole process is carried on under strict chemical control, for which a whole-time chemist has been employed. All the cane entering the factory is weighed on a platform weighing balance. The juice is measured in tanks. The sugar is weighed by an automatic balance, as it is being bagged. Samples of first mill juice, last mill juice, and mixed juice are obtained every hour. All the samples are mixed, and analysed every twelve hours. Samples of megass are obtained and analysed every two hours. Samples of syrup, mixed massecuite, first molasses, final molasses, sugar, and scum-press cake are obtained and analysed once a day.

The following methods of analyses are followed :—

Juice.—Total solids are determined by the Brix saccharimeter. For polarization, 5 c.c. of basic lead acetate solution is added to 100 c.c. of juice. Occasionally a determination of glucose by Fehling's test is made.

Megass.—In daily routine work only sugar and moisture are determined. At the beginning of the season and some time during the season as occasion offers a fibre determination is made and this figure is accepted for the rest of the season. Moisture is determined by drying 50 grams of sample in a tarred tin dish, for 5 hours, in a steam oven at 105° C. For sugar determination 100 grams of megass are digested with 950 c.c. of water and 7 c.c. of sodium carbonate solution, for about half an hour. Then the contents are weighed, the amount of fibre previously determined is deducted from the weight, and to 100 c.c. of the solution thus obtained 2 c.c. of basic lead acetate solution are added. It is then filtered, and polarized in a 100 m.m. tube.

Syrup.—Total solids are determined by the Brix saccharimeter, and sucrose by direct polarization, using normal weight of 26 grams and 5 c.c. basic lead acetate solution.

Massecuite.—Total solids are determined by the Brix saccharimeter after diluting the massecuite with equal weight of water, and the reading doubled. The sucrose is determined by using the normal weight, polarized in a 200 m.m. tube, and the reading doubled.

First molasses are analysed in the same way.

Final molasses.—In this, only the purity is determined. For this the molasses is diluted with water, and, on this diluted solution, Brix and polarimetric determinations are made.

Scum Cake.—In this, only the sucrose is determined, by digesting the normal weight in water for half an hour, making up the volume to 100 c.c., and polarizing in a 200 m.m. tube.

Method of judging the mill work.—This is not judged by the conventional methods of 'Extraction' but by a novel formula devised by the Chemist. The volume of mixed juice obtained, is calculated to first mill juice and from the other analytical results it is ascertained how much of first mill juice is lost, per 100 of fibre in megass, by the formula :—

$$\text{Normal juice in megass per 100 fibre} = \frac{\text{per cent. sucrose in megass} \times 100 \times 100.}{\text{per cent. sucrose in first mill juice} \times \text{per cent. fibre in megass.}}$$

The result for different types of milling plants used by the factory in successive years affords an interesting series of figures :—

Six Roller mill with ...	13·4	maceration ...	99·10
,,	9·1	,, ,,	104·60
Eight Roller mill with ...	21·1	,, ...	85·44
,,	20·9	,, ...	70·95
,,	19·4	,, ...	71·65
,,	20·54	,, ...	71·10
Fourteen Roller mill with	48·45	,, ...	50·00

The present season, for which the last figure is given, is not completed as yet. This season, the raw material was exceedingly bad, part of the cane was burnt cane, and the rest was very fibrous, with low sucrose content, and the juice very gummy. Therefore this year's figures are abnormal. In the accompanying tables the figures for the last six seasons as well as those for the present season up to the time of writing are given.

	1905.	1906.	1907.	1908.	1909.	1910.
Tons of cane ground ...	1586·15	2142·6	4078·25	4306·2	3728·5	4831·00
Hours grinding ...	...	131·5	200·30	203·75	185·75	229·50
Tons of cane ground per hour ...	..	18·6	20·33	21·20	20·06	21·05
Mixed juice, galls. ...	243750	350000	701700	753400	644000	835840
,, tons ...	1170·76	1710·44	3355·14	3585·6	3092·2	3980·5
Maceration water, galls.	...	...	...	138750	112268	152040
,, tons ...	...	...	...	620·3	497·1	678·2
First mill juice, galls. ...	...	...	...	614762	531772	683436
,, tons ...	...	...	...	2961·7	2561·8	3402·2
Indicated sucrose, tons	197·50	278·37	495·19	528·11	451·59	606·58
Available sugar, tons	176·74	...	432·59	457·02	387·39	526·41
Sugar made, tons	163·00	247·02	423·50	469·06	402·00	539·74
Sucrose in scum cake, tons	17·52	26·38	45·47	48·65	37·30	48·32
Galls. of final molasses	77·07	109·00	208·33	...	...	...
Maceration % on 1st mill juice ..	13·40	9·10	21·16	20·9	19·4	20·3
Recovery on indicated sucrose	82·47	83·33	85·50	88·9	89·16	88·9
Recovery % on cane ...	10·31	9·52	10·37	10·91	10·80	11·1
Tons of cane used per ton sugar ...	9·73	10·51	9·64	9·17	9·26	8·95
First mill juice lost per 100 fibre ...	9·010	10·16	8·41	7·140	7·145	7·11
First mill juice extracted %, on cane.	65·25	64·20	67·10	68·85	68·78	68·55
Sucrose extracted %, on cane	12·16	11·42	12·14	12·27	12·12	12·24
Sucrose lost %, on cane ...	2·32	2·80	2·50	2·04	2·03	2·12
Total sucrose % in cane	14·78	14·31	14·44	14·51	14·15	14·06

	1905.	1906.	1907.	1908.	1909.	1910.
Cane—						
Fibre	14·91	15·05	15·06	15·21	15·27	15·28
Sucrose	14·78	14·31	14·44	14·51	14·15	14·06
Megass —						
Moisture ...	44·52	49·81	47·41	46·47	46·34	46·50
Fibre ...	50·60	50·52	48·52	45·06	45·20	45·11
Sucrose ...	7·74	7·78	6·48	6·05	6·02	6·11
First mill juice —						
Brix	21·52	21·41	20·58	20·60	20·58	21·15
Sucrose ...	20·09	18·55	18·51	18·75	18·59	19·14
Purity ...	93·50	91·23	89·93	91·00	90·55	90·49
Mixed juice —						
Brix	18·93	18·45	17·09	17·04	17·19	17·51
Sucrose	16·80	16·31	14·81	14·74	14·75	15·22
Purity	89·23	88·50	87·03	86·50	85·83	86·92
Syrup—						
Brix	50·42	53·85	52·12	53·26	54·77	57·09
Sucrose	44·77	47·34	45·26	48·09	49·48	45·50
Purity	88·80	87·90	86·83	88·00	88·20	88·20
First Massecuite —						
Brix	93·26	92·51	93·56	...		
Sucrose	77·88	79·71	77·81			
Purity	83·49	86·10	83·20			...
Second Massecuite—						
Brix	88·72	87·85	89·64	88·83	90·12	91·42
Sucrose	52·77	57·63	53·68	52·25	53·05	58·36
Purity	59·50	65·60	59·90	58·81	58·90	63·80
First Sugar—						
Polarization	96·04	95·63	96·09	...		
Second Sugar—						
Polarization ...	80·27	83·17	81·79			
Final Molasses—						
Purity	52·10	48·90	44·80	42·00	39·50	39·37
Scum Cake—						
Sucrose	11·05	10·80	11·15	11·29	12·01	11·10

Statement showing the work of the Factory up to the time of writing for the present season 1911.

	Moisture.	Fibre.	Brix.	Sucrose.	Purity.	Glucose.	Glucose ratio.
Cane ...		15·46	...	14·21	...	...	...
Megass ...	47·89	44·86		4·83			
First mill juice	...	...	21·03	18·65	88·72	0·67	3·60
Mixed juice	...	...	18·40	15·51	84·46	0·79	4·35
Last mill juice	...	...	9·59	7·31	76·5	..	...
Syrup	...	..	50·92	43·84	86·1		...
Second massecuite	...	...	92·06	60·46	65·7	...	...
Sugar ...	...		...	95·55			...
Final Molasses ...	...	..	..		41·45	...	...
Scum cake	...	...	...	9·62			...

Maceration % on first mill juice ...	...	14·45
Recovery on indicated sucrose ...	...	84·92
,, % on cane ...	...	10·66
Tons of cane used per ton of sugar ...	..	9·38
First mill juice lost per 100 fibre	...	57·73
First mill juice extracted on cane	...	70·61
Sucrose extracted % on cane ...	...	12·55
Sucrose lost on the ...	...	1·66
Total sucrose in cane ...	...	14·21
Tons of cane ground	...	36,639
Hours grinding	...	1510·5
Tons of cane ground per hour ...	...	24·26
Mixed juice, gallons	...	6,212,0[illegible]0
,, ,, tons	...	29698·91
Maceration water, gallons ...	...	...
,, ,, tons ...	...	3730·10
First mill juice, gallons ...	...	5,341,07[illegible]
,, ,, ,, tons ...	...	2857·75
Indicated sucrose, tons	...	1509·70
Available sugar, tons ..	...	388·7
Sugar bagged, tons ...	...	3,[illegible]7·5
,, in process of manufacture	...	198·5
Total sugar made, tons ...	...	3,[illegible]6
Sucrose in scum cake, tons ...	...	36·64
Gallons of 2nd massecuite ...	...	211,745
Molasses drawn in first strikes ..	...	196,385
Hours working of vacuum pans ...	...	89·35
		—
		...
Number of strikes from vacuum pans	...	238
Hours out of cane	...	26·22
		—

The Staff.—As the factory has been extended from year to year, the staff also has increased. At present the staff is as follows :—

Labour.—(During the season in two shifts day and night).

Mill Department.—Fifty-two men.

Clarification Department.—Twenty-eight men.

Boilers, Ash-pit, Megass, etc.—Twenty men.

Factory Engine Drivers.—Four headmen, forty-four other hands.

Triple-Effects, Pans, Filter Press, etc.—Twenty-four men.

Curing Sugar.—One headman and 5 other hands.

Cleaning Machinery, Buildings, Yards, etc.—Twenty men.

Packing and delivering Sugar by contract.—Twenty-eight men.

Attendants, Store-keepers, Watchmen, etc.—Eleven men.

Mechanics' shops.—Fifteen men.

RAILWAY.

Locomotive Drivers.—4 men.
,, *Firemen.*—4 men.
Extra hands.—4 men.

SUPERVISION.

1 Manager.
1 Accountant.
1 Engineer.
1 Chemist.
1 Deputy Manager.
1 Assistant to the Chemist.
1 Cane weigher.
5 Overseers.
4 Clerks.
6 Pan boilers.

Manufacturing Expenses.—The manufacturing expenses per ton of grey crystal sugar polarizing 96° during the last six seasons have been as follows :—

	1905.	1906.	1907.	1908.	1909.	1910.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Factory charges	2 10 0	2 8 3	2 2 1	2 3 5	2 11 9	2 12 1½
Railway transport	0 4 6	0 10 11	0 9 7	0 11 7	0 9 0½	0 10 6½
Administration	0 8 0	0 4 9	0 2 10	0 3 2	0 3 3½	0 4 2½
Interest	0 16 4	0 12 6	0 6 10	0 7 7	0 9 2	0 7 7½
Total manufacturing expenses	3 18 10	3 16 5	3 1 4	3 5 9	3 13 2½	3 14 5½
Cost of cane	5 12 4	3 18 10	4 16 5	5 5 3	4 19 4	5 19 2
Total cost per ton of sugar	9 11 2	7 15 3	7 17 9	8 11 0	8 12 6½	9 13 7½
Net value ,, ,,	12 15 5	8 4 8	9 16 0	11 15 9	10 7 5	12 6 8
Net profit ,, ,,	3 4 3	0 9 5	1 18 3	3 4 9	1 14 10½	2 12 0½

Financial Condition.—When the factory was started in 1905, the total capital expenditure was £45,358-14-9. Since that time additions have been made from year to year which up to 1910 amounted to £14,410-8-11, making the total capital expenditure £59,769-3-8, which is made up as follows :—

	£	s.	d.
Land, buildings, plant and machinery	42,198	16	1
Dwelling-houses and other buildings	1,279	9	7
Railway construction and rolling stock	14,184	8	5
Preliminary expenses...	946	9	7
Discount on debentures	1,250	0	0
Total ...	59,769	3	8

In 1911 extensive additions were made, but the actual figures for them are not as yet available. With this capital expenditure the Company has made the following net profits in different years after paying the interest on debentures, and after providing for the sinking and reserve funds :—

	£	s.	d.
1905	3,918	1	8
1906	331	17	10
1907	6,345	10	8
1908	14,163	2	5
1909	8,266	14	11
1910	14,462	15	2
Total ...	47,198	2	8

A part of these profits was paid to the estates other than the original contractors as a special bonus, and the rest of the sum was divided equally between the "A" and "B" shareholders.

The profit and loss account of the Company for the year 1910 was as follows:—

	£	s.	d.	£	s.	d.
Dr. by cost of cane				32,215	5	5
By Factory Charges—						
Salaries	2,227	2	8			
Wages	2,913	17	2			
Fuel	463	16	7			
Bags	1,329	11	8			
Stores (manufacturing) ...	932	5	10			
„ (engineering)	2,454	6	5			
Repairs and maintenance ...	2,922	4	8			
Fire and storm insurance ...	234	12	3			
Storage and lighterage of sugar	570	1	5			
				14,047	18	8
By Railway Charges—						
Wages	257	17	7			
Fuel	582	19	4			
Stores	120	1	9			
Repairs and maintenance ...	1,879	6	8			
				2,840	5	4
By Administration Charges—						
Director's fees	259	0	0			
Travelling	203	16	7			
Legal	264	4	2			
Stationery and sundries ...	177	9	10			
Telegrams and postage ...	147	8	3			
				1,132	18	10
By Interest Charges—						
Debenture interest	930	19	9			
Interest and exchange ...	1,008	2	11			
Income tax	110	5	2			
				2,049	7	10
By Sinking fund		.		2,000	0	0
Addition to sinking fund ...		...		3,000	0	0
To contracting planters ...		...		7,231	7	7
To shareholders		...		7,231	7	7
Total ...				71,748	11	3
Cr. to sugar		...		69,178	16	6
Molasses		...		2,569	14	9
Total .				71,748	11	3

SUGARCANE CULTIVATION IN THE LEEWARD ISLANDS.

By G. N. SAHASRABUDHE, B.Ag.

Introductory.

The Leeward Islands is a group of small islands situated in 15° to 20° North Latitude and 60° to 65° West Longitude. The following islands are included in this group, *viz.*, (1) Antigua with Barbuda and Redonda, (2) St. Kitts, Nevis and Anguilla, (3) Montserrat, (4) Dominica, and (5) Virgin Islands. In most of these islands, sugarcane is grown to a greater or less extent, but it is in Antigua, St. Kitts and Nevis only that the cultivation is on an extensive scale. In other places the industry is on a very small scale only, supplying a part of the local demand for sugar or for rum. But in Antigua, St. Kitts and Nevis this is the most important industry. The following are the average figures for 1908-09 :—

	Cultivated land	Area under Cane
	Acres.	Acres.
Antigua	18,475	15,977
St. Kitts and Nevis ...	29,359	15,339

Formerly sugarcane was practically the only industry of these islands, and when it was in danger of extinction, on account of the extreme depression of the sugar market due to sugar bounties in Europe, and the ravages of cane diseases, the people here were threatened with ruin because no other industry could be found to supplant sugar-growing. But these circumstances have changed now. Diseases have been kept in check by the introduction of more resistant varieties, the abolition of sugar bounties in Europe has brought the sugar market to a normal condition and the sugar industry is again fairly well off. During

the crisis referred to above, various attempts were made to introduce some other crop to take the place of sugarcane, but they were more or less unsuccessful. The cultivation of Sea Island Cotton appears promising, and it has already made considerable progress in St. Kitts and Nevis. In Antigua this crop does not seem to be very successful and no other has yet been found which will take the place of cane in this island. Therefore, in Antigua though cotton, limes, sweet-potatoes, yams, etc., are grown to a certain extent, more than three-fourths of the cultivated land is under sugarcane.

Climate.—The climatic conditions in these islands are very peculiar and are entirely different from those obtaining in India. In the first place, on account of the insular position, the temperature variations in these islands are but slight, as will be seen from the following figures :—

	Maximum.	Minimum.	Mean.
Antigua	90	62	82·2
St. Kitts	89	62	79·8
Nevis	93	61	78·3

As there is practically a uniform temperature all the year round and as there is no regular winter period, the growth of cane is fairly even, but the period of growth is lengthened. The other distinctive feature of the climate is the rainfall. There is no particular rainy season and it rains here in every month as will be seen from the following figures for 1909-1910 :—

	Antigua.			St. Kitts.	
	North.	Centre.	South.	North.	South.
April 1909	2·49	2·54	3·92	2·00	1·80
May ,, ...	1·40	2·10	2·22	3·15	1·51
June ,, ...	2·21	3·82	3·94	8·64	6·06
July ,, ...	2·54	2·03	2·52	3·00	5·45
August ,, ...	4·65	6·11	7·05	7·09	9·39
September ,, ...	4·23	4·13	6·51	4·28	3·05
October ,, ...	5·85	4·14	4·18	5·30	4·31
November ,, ...	8·18	11·01	11·10	16·60	8·00
December ,, ...	1·82	1·09	0·92	3·04	6·29
January 1910	2·76	3·72	4·00	3·82	2·81
February ,, ...	0·64	1·18	1·47	1·40	1·84
March ,, ...	2·34	1·87	2·16	0·58	1·53
Total ...	39·11	44·64	49·99	58·19	52·04

From this it will be seen that the rainfall is fairly well distributed all the year round, and thus in normal seasons there is a vigorous growth of the crop. But such years are rather few and far between. Generally the planters, and especially in Antigua, have to labour under uncertainty of weather. An abnormal season affects the crop in two ways, by the absence of rain for a long unbroken period when it withers, or by abnormal distribution though the total precipitation might reach the normal figure, in which case the plant makes a very uneven growth. These difficulties are augmented by the fact that there is no source of irrigation to save the crop in case rains fail. There are no rivers or streams worth the name, so that canal irrigation is practically out of the question except possibly in St. Kitts. Very little is done in the way of boring wells and thus there is no well-irrigation. There is probably a vast field for well-irrigation here, both ordinary and artesian, because there is a very cheap source of power available for drawing out the water. In India, well-irrigation is very costly because of the cost of drawing out the water with bullock power or occasionally oil-engine. Here strong trade-winds blow all the year round. Their force is so great that a few years ago all the crushing of cane was done by wind power. With such a cheap source of power near at hand, it is somewhat difficult to understand why well-irrigation is not practised. The probable causes are lack of enterprise, some failures in getting water suitable for irrigation and also on account of the peculiar land tenure system and labour conditions obtaining.

Soils.—These islands are mostly of volcanic formation, yet there is a great variety of soils. In Antigua there are three distinct soil formations. In the north and north-east the soil is formed from calcareous marls and coarse lime stones, in the central part the soil is a stiff clay or clay loam, while in the south and south-west which is very hilly and of volcanic origin the soil is similar to that of other volcanic islands, being fairly well drained and very fertile. In St. Kitts the soil is very porous, containing a large amount of sand and is very deep. In Nevis the soil is usually clay loam and abounds in boulders. In Antigua most of

the soils are very stiff and difficult to drain, and extensive drainage is practised even at a great cost. In St. Kitts the reverse is the case. There the soil is so porous and sandy that attempts have to be made to prevent the washing of the soil by heavy rainfall. Nevis being very hilly there is good natural drainage in many of the soils and only a few soils require artificial drainage.

Preparation of the land.—In St. Kitts the preparation of the land is a very simple operation. The soil being friable it is always well aerated and does not require deep ploughing. Were there a regular dry season, the ploughing would be simpler still, but the occasional showers keep the land always in a moist condition, thus increasing the work of ploughing even in this soil. The plough used is of a very heavy fixed-mould-board type and cuts a very broad furrow, usually 2—2½ feet. A team of 12 bullocks is required to draw this heavy plough and usually the team is worked in two shifts. Thus 3 men and 24 bullocks plough 2 acres in a day. In Nevis and Antigua the ploughing is a much more difficult operation. The stiff soils being always more or less moist put a heavy strain on the bullocks. Here deep ploughing is necessary to aerate the soil properly. The plough used is of the same heavy, fixed-mould-board type, but cuts a narrower and deeper furrow. A few disc ploughs are used in Nevis and there are two sets of steam ploughs in work in Antigua.

On account of the weather conditions and the scarcity of labour and cattle, the preparation of land is usually confined to one ploughing. Where circumstances permit, cross ploughing or harrowing is done, but there is rarely any time for these operations. As a rule, the previous crop is taken off in April or May, and then the land is either planted with an intermediate crop like cotton or some green-manuring crop or is left fallow till the next planting season. In either case, the ploughing is usually done in June, or left over till December, the intermediate months being too wet to do any tillage. If the land is ploughed in June, then it receives another ploughing or harrowing in December or January, before the furrows for planting are prepared. Some-

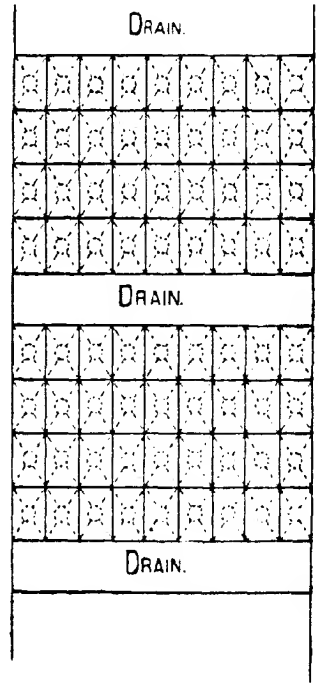
times, especially in St. Kitts, to economise time and labour the whole field is not ploughed but only the old ridges are broken up to form new furrows, while the earth is thrown on the old furrows converting them into new ridges.

The scarcity of labour and cattle is the chief obstacle in the proper preparation of land. To meet this difficulty two of the bigger estates in Antigua have resorted to steam ploughing. Both these sets are supplied by Messrs. Fowler and Sons, Leeds, England, and each consists of a pair of steam traction engines drawing a balanced reversible plough alternately backwards and forwards by means of a steel cable. The ploughs are fitted with three mould-boards and shares, each cutting a furrow 2—2½ feet in width. One of the sets which is worked on a medium soil, was found to work 3—6 acres per day. But the land on which the other set is worked is so stiff that only two shares can be used and even then they are able to work up only 2—4 acres in a day.

In Antigua, on account of the heavy nature of the soil, there is one operation before the furrows for planting are cut, and that is, making the drains. There are two systems of drains here, *viz.*, parallel drains and cross drains. The system of parallel drains appears to be a recent introduction, its advantage being the facility it gives for intertillage. Sometimes the drains have to be made irregularly according to the contour of the soil. Usually the drains are made 20—40 feet apart. In very stiff soils, drains have to be made 15 feet apart. The drains and planting furrows are made either by a double mould-board-plough or by taking two cuts with an ordinary fixed mould-board-plough and afterwards finished by hand. The soil not being subjected to flooding as there is no artificial irrigation, and on account of the clayey nature of the soil, the drains remain intact when once made, even though the sides are very steep. The drains are 2 feet wide at the bottom and 2½ to 3 feet wide at the top.

Planting. The planting furrows are made 4 to 5 feet apart. Occasionally furrows 5½ feet and even 6 feet apart are met with.

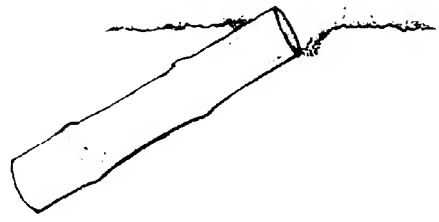
They are either continuous except where cut by the cross drains or are divided up by cross bars. This second system is called "Cross holing." It is the general system of planting in St Kitts, Nevis and many parts of Antigua. In this system cross ridges are made between each set as shown in the following sketch :—



This system is admirably suited for light well-drained soils and where the rain comes in short showers as is the case in these islands. By "Cross holing" all the rain water is collected at the root of the plants and also washing of the soil by any excess of rain is avoided to a certain extent. One drawback of "Cross holing" is that it makes intertillage with implements a difficult and less effective operation than is the case with continuous rows

But on light soils the growth of weeds is not very prolific and it can be checked very easily.

The planting season is usually December, January and the early part of February. The land is not usually ready for planting in November, while if the planting is deferred till the later part of February, the young plants do not get sufficient moisture to make a good stand. The sets are planted, in furrows, usually 3—4 feet apart. The method of planting is peculiar. First the sets are distributed at the proper distance all over the field. Then a man comes with a crow-bar, with which he makes a slanting hole in the ground, puts the set in the hole, and presses it with his foot, so that most of the set is buried in the ground, its position becoming like this :—



As the number of sets to be planted is very small, this is a cheap and quick method of planting, and it is certainly of advantage where cane has to be grown on rain water alone. Here at the time of planting the surface soil is usually dry and the set has to be planted deep enough where it will get sufficient moisture for germination and where it will be protected from the scorching rays of the sun till the sprout comes out. The number of sets required per acre depends upon the distance between the

furrows and between the sets. Usually the figure varies from 1,700 to 3,000 sets per acre. The following are the figures for different methods of planting :—

Distance in feet between furrows sets.	No. of sets per acre.
5 × 5	1,742
5 × 4½	1,910
6 × 4	1,815
5 × 4	2,178
5 × 3½	2,488
5 × 3	2,904
4 × 3	3,630

The nature of sets, *i.e.*, whether the tops (or cabbage plants as they are called in Antigua) or from whole canes depends upon the convenience of the estate. But usually tops are planted as far as possible. There appears to be a belief among the planters in Antigua that tops do not grow well when planted early, *i.e.*, in December, but they do well when planted in January. This is similar to the current belief in the Bombay-Deccan where it is considered that the tops do well when planted in winter, but for summer planting sets from whole cane are preferred. The reasons for these beliefs appear to be quite different. Tops are tender and cannot withstand drought In Antigua December is usually dry, hence tops planted in this month do not fare well. In the Deccan the trouble is not with the moisture but with the heat of summer

Intertillage.—After planting the only operation up to the time of harvest is weeding, either by hand or by implements. A few years ago, one of the estate owners here paid a visit to Louisiana, and the system of implemental tillage there attracted his attention. As a result, a set of implements was introduced into Antigua and the "Louisiana system" extensively tried. This system appears to consist of hoeing and harrowing constantly to stir the surface soil. For all practical purposes the object is the same as in "Dry-farming," *viz.*, to prevent surface evaporation of soil moisture. As stated above, the system was followed wholesale without taking into consideration the local

conditions in Antigua. For the proper use of the implements the sets had to be planted on the tops of the ridges instead of in the furrows. But this was not suited to the rainfall conditions of Antigua, and it was soon found to be more or less of a failure. Still a good lesson was derived from this experience, and planters in Antigua now have come to appreciate implemental tillage better than they did before.

Manuring.—As the sugarcane crop in these islands is entirely dependent on rain water, and as the supply of this is, by no means, very great, intensive cultivation cannot be practised here, and the system of manuring is very simple. The usual manures for plant canes in these islands are farm-yard manure and green-manuring. Twenty tons of farm-yard manure is the usual dose. The plants usually used for green-manuring are: Pigeon Pea (*Cajanus indicus*); Wooly pyttol (*Phaseolus mungo*); Cowpea (*Vigna catiang*); Horse beans (*Canavalia ensiformis*); and Lima Bean (*Phaseolus lunatus*) The green dressing crop is usually planted in June or July and buried in at the time of planting. Sometimes the crop is planted with cane and subsequently buried in. The use of pigeon pea as green-manure appears curious to an Indian observer. The plant is woody and does not rot very quickly. On the other hand, it appears equally curious that Sann (*Crotalaria juncea*) which is considered to be the best green-manure crop in India is unknown here. Concentrated organic manures, like oil-cakes and fish refuse, are also unknown. It has been found by experience that artificial (Chemical) manures do not give any appreciably better results with plant canes here, and usually the use of such manures is confined to ratoon canes. All the manures are given in one dose, before or at the time of planting, it having been proved by Dr. Watts that sugarcane makes the largest demand for plant-food during the early period of growth.

Ratoon Crop.—When in the last quarter of the 19th century the position of the sugar industry had become exceedingly precarious, it did not pay to plant canes very often,

and in order to save expense of planting, a system of long ratooning had come into vogue. But owing to the ravages of fungoid diseases this tendency has decreased and now usually it is not carried beyond the third ratoon. After the plant cane is harvested, all the trash is arranged on alternate banks and the middle banks are ploughed up. At this time usually a dressing of some artificial manure like Nitrate of Soda or Sulphate of Ammonia is given at the rate of about 2 cwt. per acre. After this the crop does not require any further attention. When the first ratoon crop is harvested, all the trash is arranged on the alternate banks which were previously ploughed up and the banks on which the trash was arranged formerly are now ploughed up. So that the positions in successive years are as follows :—

Plant Cane	First Ratoon	Second Ratoon
Cane row	Cane row	Cane row
Middle bank	Trash arranged	Ploughed up
Cane row	Cane row	Cane row
Middle bank	Ploughed up	Trash arranged
Cane row	Cane row	Cane row
Middle bank	Trash arranged	Ploughed up
Cane row	Cane row	Cane row

This system of utilising trash is very interesting, though obviously it can be practised only where the crop is grown on rainfall alone and no artificial irrigation is given.

Varieties under cultivation. Ever since the cultivation of sugarcane was introduced in these islands till the outbreak of rind and root fungus, Bourbon was practically the only variety under cultivation. But disease has practically swept out this variety; since the outbreak of the rind fungus several new varieties have been tried and are being tried. Some of them have withstood the attacks of the disease to a greater or less extent, and these have come into general cultivation. The following figures show the acreage under some of the more

important varieties in Antigua and St. Kitts for 1910 and 1911 as far as the returns are available :—

Variety.	Antigua.		St. Kitts.	
	1910.	1911	1910.	1911.
Bourbon ...	68½	31	4	9
White transparent	7,005½	6,218½	1,685	1,794
Sealy seedling ...	761	721	...	10
B. 109	135½	102⅔	89	120
B. 147	674	861½	3,272	3,711
B. 156	68½	52½	...	...
B. 208	358½	437½	1,629	1,315
B. 306	68½	85	42	42
B. 376	3½	2½	...	...
B. 1,753	21½	46½	...	19
B. 4,596	74	41½	...	149
D. 74	8	15½	5	1
D. 95	325½	414½	8	4
D. 109	59½	193	...	...
D. 115	½	½	47	15
D. 116	½	½	86	72
D. 625	48	2	...	3
Total area for which variety returns are available	9,613½	9,222	6,867	7,264

Financial Results. Cost of Cultivation.—Mr. Moody Stewart in the West Indian Bulletin* gives figures for the cost of cultivation in Antigua, which, calculated to an acre basis, are as follows :—

	£	s.	d.
Clearing land for ploughing	0	4	2
Lining	0	1	0
Ploughing twice	0	6	2
Harrowing twice	0	1	0
Taking out bars	0	15	0
Trenching	0	18	9
Hoe weeding	1	4	8
Cross holing	0	5	6
Planting and supplying	0	4	3
Carting manure and spreading	0	10	6
TOTAL ...	4	11	0
To this have to be added—cost of 2,000 sets, say... ...	0	8	0
Manure 50 cartloads (25 tons), say	2	10	0
TOTAL ...	7	9	0

* Vol. X, p. 327.

The following estimate given to me by an Estate Manager in St. Kitts shows the cost of cultivation there :—

	£.	s.	d.
Ploughing	0	9	4
Arranging trash	0	3	6
Cross holing and head banking	0	4	6
Planting	0	1	4
Cost of 2,000 sets, say	0	8	0
Subsoiling twice	0	2	3
Weeding, cutting and tying	1	5	10
Carting and spreading manure	0	11	3
Cost of manure 25 tons = 50 cartloads	2	10	0
TOTAL ...	5	16	0

Of course, all this is not actual cash outlay, but shows what the cost would be if everything was paid in cash.

The manager of two estates in Nevis who keeps careful account of all the cultivation charges gives £6-7-6½ and £6-10-6 respectively as the cost of cultivation per acre on these two estates.

Outturn.—The outturn of cane per acre varies considerably in different islands and in different parts of the same islands. The crop here being entirely dependent on rain, the character of the season also causes a good deal of variation in the outturn. Also the nature of crop, *i.e.*, whether plant or ratoon, makes a considerable difference. The following are the results per acre in the area worked by the Antigua Central Sugar Factory in the last six seasons :—

Year.	Outturn Cane.	Rate per ton.			Value of outturn		
		£	s	d	£.	s.	d
1905	10·8	0	14	1	7	12	1
1906	12·8	0	7	5	4	14	11
1907	14·9	0	12	3	9	2	6
1908	13·4	0	15	11	10	13	3
1909	11·2	0	14	0	7	11	1
1910	13·9	0	13	4	9	5	3
Average	12·8	0	12	10	8	3	2

These figures are general averages and include all sorts of crops, *i.e.*, plants and all ratoons. Still it will be seen that sugarcane is hardly a paying crop in Antigua.

I obtained the following figures for two estates in Nevis :—

		I.	II.
		Tons.	Tons.
Outturn (plants) maximum	...	26·85	28·34
Minimum	...	7·70	6·09
Average for the whole area	...	17·79	16·96
Outturn per acre (ratoons) maximum	...	25·60	...
Minimum	...	3·99	...
Average for the area	...	13·62	...

I could not get any accurate outturn returns for St. Kitts on an estate scale. The planters there estimate the outturn as from 20 to 35 tons per acre. Looking at the crop I could easily see that the outturn in St. Kitts was decidedly higher than that in Antigua and Nevis, but in the absence of any actual data I cannot say how far the planter's estimates are correct. But probably 25 tons for plant canes, about 17 tons for ratoon canes and 20 tons for the general average of the whole crop are more near the correct figures.

It is at present difficult to estimate the money value of this outturn in St. Kitts and Nevis, because at present all the cane is worked up on the estates themselves. A Central Factory is at present being erected in St. Kitts, which will pay for cane at the rate of the value of $4\frac{3}{4}$ tons of grey crystal sugar per 100 tons of cane *plus* profits. Taking the average outturn of cane in St. Kitts as 20 tons per acre and taking the average price of cane at 13 shillings per ton, the 20 tons of cane mean £13. This shows that sugarcane cultivation is decidedly paying in St. Kitts.

The following figures are from an estate in Nevis :—Per acre outturn of cane 16·91 tons which gave 1·142 tons muscovado sugar and ·265 tons of muscovado molasses, the money value of which was approximately £12-1-9. The cost of cultivation was £6-10-6 and the cost of manufacture was £1-4 11, giving the total expenses as £7-15-5. This leaves a net profit of £4-6-4 per acre.

THE RICE INDUSTRY OF BURMA.

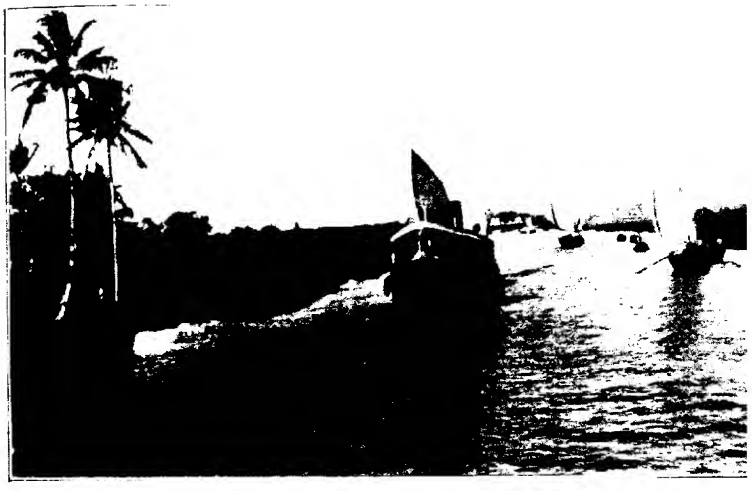
By F. J. WARTH, M.Sc.,
Agricultural Chemist, Burma.

It is desirable that all concerned with the welfare and commerce of the province should be acquainted with the agricultural and economic conditions under which the great rice trade of Burma exists. These conditions, it is hoped, we will be enabled at least partially to realise with the aid of the few data which it has been possible to collect for this article.

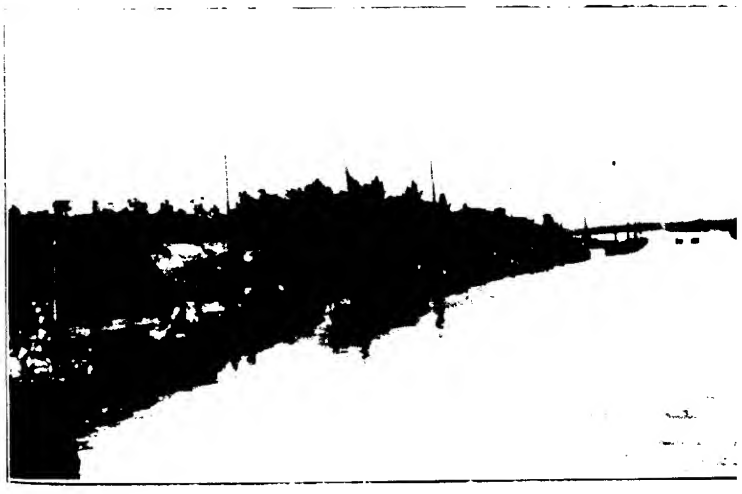
The total cultivated area in Burma is at present about 13·5 million acres, of which no less than 10 million acres are devoted to paddy. From the cultivator's point of view, therefore, it is incomparably the most important crop. That it forms the staple and in many cases the only food of the people is clear, seeing that the product of nearly 6 million acres is consumed in the country. From the commercial point of view, again, the position of paddy is unique. At the present time the value of paddy and paddy products amounts to 70 per cent. of the entire annual export trade of the province. In the year 1895-96 the rice exports were valued at 96 million rupees and in 1909-10 the figure had risen to well over 222 million rupees. That is to say, the trade has more than doubled within the last 15 years.

It should be mentioned here that almost all the paddy is husked and milled before being shipped. In addition to the export trade, therefore, there is in Rangoon and the other seaport towns a very large milling industry which depends upon the paddy crop. The milling and export trades naturally also support a large internal carrying trade. The railway lines are literally choked with traffic during the season, and enormous heaps of paddy, sometimes quite exposed to the weather, have to lie for months at every station before they can be dealt with

PLATE XIV.



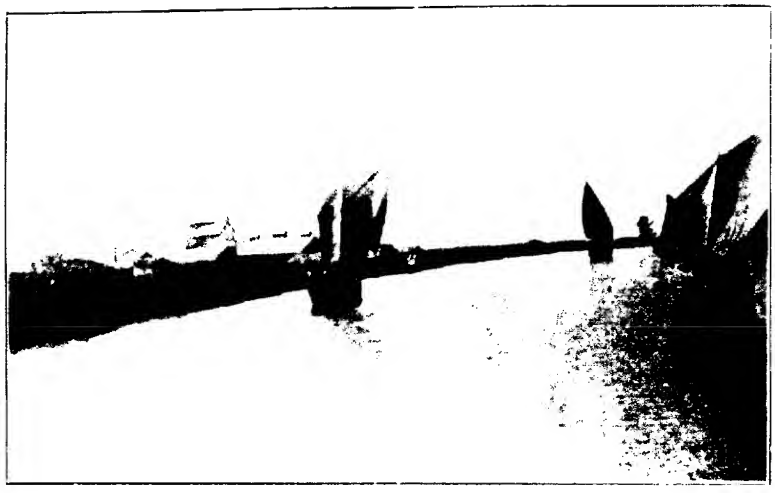
The Irrawaddy Flotilla [illegible] the Delta Paddy comes to Rangoon.



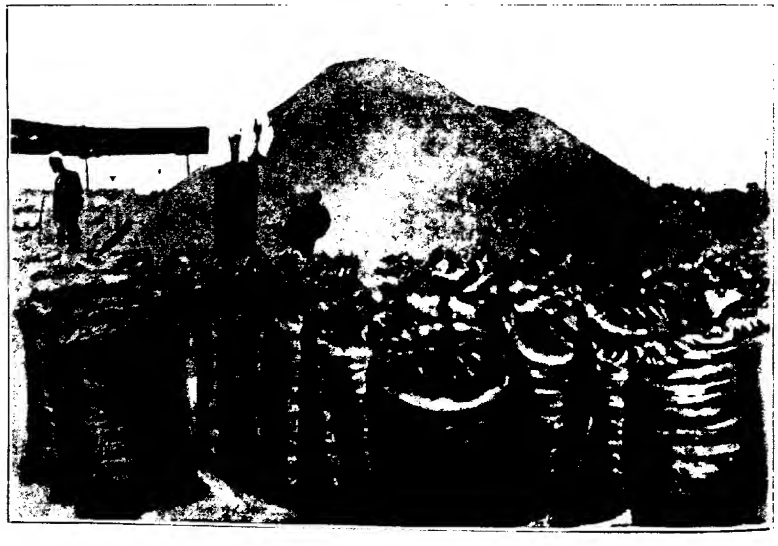
A Row of Paddy Cargo Boats.

A. J. I.

PLATE XV.



JUNGLE PADDY MILL AND PADDY CARGO BOATS UNDER FULL SAIL NEAR RANGOON.



SHIPPING PADDY IN SACKS AND IN BULK. HLINE RIVER, NEAR RANGOON.

A. J. L.

The transport and storage problems are amongst the most serious of the many that exist. On the waterways of the Irrawaddy, again, the steamers of the Flotilla Company, unnumbered cargo boats, and picturesque Burmese sailing vessels reap a splendid harvest as carriers.

However, if a true idea is to be gained of the paddy production and export, we must look beyond our own borders, and examine figures from the other paddy-growing provinces also. The average annual export of paddy, rice and rice products from Burma during the last 5 years has amounted to nearly $2\frac{1}{2}$ million tons. Compare this with the export from Bengal. As almost all the rice for export from Bengal is shipped from Calcutta, the figures for this port alone will suffice to show the magnitude of the rice trade of the province.

TABLE I.—Showing rice trade of Calcutta.

	1909-1910.	1910-1911.
Total export	252,000 Tons.	342,000 Tons.
Value of total export	336 Lacs, Rupees.	442 Lacs, Rupees.
Total value of rice imported from Burma	52 Lacs, Rupees.	53 Lacs, Rupees.

From these figures it appears that the export of rice grown within the province of Bengal is only considerable during such good seasons as 1910-1911. From Eastern Bengal and Assam the exports are much less and no other province exports any notable quantities. It is evident, therefore, that Burma holds an undisputed first position in the export of rice.

In the matter of rice production, however, we are very far behind Bengal and Assam as the figures in the accompanying table show.

TABLE II.

Province.	Population.	Area under paddy (in acres)
Bengal ...	52,656,000	25,000,000
Eastern Bengal and Assam	33,978,000	16,700,000
Burma	12,058,000	10,000,000
Madras ...	41,402,000	7,800,000

These four provinces between them produce 80 per cent. of the rice grown in the Indian Empire. The table shows that although Burma is by no means pre-eminent as a rice-producing country, still it holds an important place in this respect even. The data also explain why Burma is able to export so much.

In Bengal and Assam the population is seen to be about 2 per acre of rice, while in Burma there is just over one individual per acre. Hence in the latter Province the excess of rice per acre must be much greater than that in Bengal and Assam.

To determine the actual available excess of paddy the average consumption per head must be ascertained. Allowing for waste during storage and from other causes, we must be prepared to set aside almost half an acre per individual. This figure will also cover the high seed rate at present universally employed. On this estimate nearly 6 million acres of paddy will be required annually as food. As 10 million acres are cultivated, there should be available for export the product from somewhat over 4 million acres. At the present rate of acre outturns (·65—·7 tons) this means about 2·5 to 2·8 million tons of paddy. These figures are seen to correspond roughly to the actual exports. If the same rate of consumption were allowed for Bengal, there could be no export of rice from Calcutta. As a matter of fact, the export (say 300,000 tons) is exceedingly small when compared with the annual production (16 m. tons). Therefore ·5 acre per individual is also a fairly accurate consumption rate for Bengal. Indeed, if the consumption for this province were to fall to ·4 acre (including seed as usual) Bengal would probably have available for export an excess of 2 million tons. These considerations confirm the estimate of ·5 acre per individual.

Leaving the actual exports, we may next briefly consider the future prospects of the export trade. As this depends upon the increase of population, the following census figures are of interest.

TABLE III.—Showing Census Returns for Burma.

Year.	Population.	Increase.	Percentage increase for decade.
1881	3,736,000		
1891	7,721,400	3,985,000	106·6
1901	10,490,000	2,768,600	35·9
1911	12,057,000	1,567,000	14·9

It is true that the rate of increase has fallen very rapidly. Still, allowing for the causes which produced rapid increase during the earlier years of development, and admitting the favourable agricultural and economic prospects of the country, it may be assumed with some confidence that the rate of increase which occurred during the last decade will suffer no great retardation now for some time. The following figures show what the population would be in 50 years and 70 years respectively at different rates of increase.

TABLE IV.—To estimate increase in population (in millions).

Rate of increase.	Year 1961	Year 1981.
10 %	19·4	23·5
12·7	21·2	26·7
14	23·2	30·2

It seems more than probable therefore that in 50 years time there will be a population of 20 millions. If during this period the acre outturns do not decline, then the 10 million acres at present under paddy would just suffice for food and seed. Now, in the chief paddy-growing districts there are over 11 million acres of culturable waste land. Considering the heavy rainfall in these parts, it may be assumed that 4 million acres could still be brought under paddy cultivation. The exports could indeed be increased considerably for a time if the available land were brought under cultivation more rapidly than the increase of population required. It is very doubtful whether this is likely to take place. It should also be remarked here that the best paddy land is already occupied and that cultivation is extending into less suitable tracts. However, with the above-mentioned additional 4 million acres,

Burma could probably still maintain the present rate of export 50 years hence provided that the yields do not decrease. But to be able to say whether the yields will or will not decrease, it is necessary to examine the existing conditions of agriculture in some detail. Now, it happens that the conditions in the chief rice-growing districts (which we may call Lower Burma for brevity) differ very much from those prevailing in the rest of the Province (Upper Burma). Therefore, in discussing the maintenance of acre yields, it will be necessary to examine each of the two regions on its own merits.

The following table of statistics makes the differences very obvious :-

TABLE V.—Agricultural Statistics for Lower and Upper Burma (1910-1911).

	Lower Burma.	Upper Burma.
Area under paddy	7,808,284	2,142,196
Other chief crops	425,027	2,779,111
Cattle including bullocks, cows, buffaloes and calves.	2,386,454	3,277,636

The numerous and detailed data, of which the above figures form a summary, are sufficiently instructive to deserve separate discussion on some future occasion. However, the figures given serve to show clearly that Upper Burma is a land of mixed farming where rotation is practised and cattle are kept in fair quantity. In this tract therefore with reasonable care the yield can doubtless be maintained. It must nevertheless be admitted that even here some of the irrigated tracts are tending to become mere paddy factories.

Lower Burma, on the other hand, very emphatically relies on a single crop. There is little or no manure available, no rotation is attempted, and every year a crop of paddy is taken and sold off the land. I have not been able to procure any data to show what deterioration has actually taken place, but it is quite certain that if agriculture proceeds on the present lines, there

must ensue a steady decline in the acre outturns. The tendency at present is to cover the whole region with paddy, with the result that all prospects of producing fodder, of raising cattle for better cultivation, and of leaving room for a certain amount of rotation are being steadily withdrawn. The end of such a system is certain and the experience of the great wheat tracts of the United States of America, where, during the last 50 years, the yield has fallen from 30 bushels to 14, shows what must eventually come to pass here.

On the other hand, it should be possible to maintain the yields if the land now vacant be used for the production of fodder and other crops. The supply of fodder will make it possible to keep more cattle and thus to improve tillage. A welcome addition of manure will at the same time be obtained. The fodder and other crops, combined, will give room for a moderate amount of rotation. They would also tend to distribute labour a little more evenly throughout the year By these means combined with improvements in seed, in cultivation and in other matters, we may hope not only to maintain the yields but to maintain them at a higher level than the present.

But, besides the question of acre yields there remains still a very important source whereby the available amount of paddy may be largely increased, namely, by preventing the waste which occurs in various directions. The following are the most obvious items in which economies might be effected :—

1. *The seed rate.* -In Burma, not less than 50 lbs. (often 70 lbs.) of seed are used per acre of paddy grown. Now, the Madras Department of Agriculture has shown us that, in some places, they can reduce the seed rate to 17 lbs. per acre without lowering the yields. If this rate, instead of the usual rate of 50 lbs were applied in Burma, there would ensue an annual saving of 120,000 tons of paddy.

2. *Loss in storage.*—This is caused partly by decomposition due to "heating," partly by insect pests.

3. *Loss in milling.*—This is usually very small, but occasionally becomes serious if the grain is very far from uniform

in size. Efforts are now being made by some Co-operative Credit Societies to grade their grain. It is to be hoped that this splendid enterprise will be rewarded with the substantial financial success it deserves.

4. *Loss in paddy pounding by the Burmese method.*—From the few figures I have so far gathered, it would appear that the actual amount of rice obtained by this method is 10 per cent. less than that yielded by the milling process. In addition to this loss, which is serious considering the large quantities involved, the bye-products from the Burmese pounding process are valueless, whilst the mills convert $\frac{1}{10}$th of the paddy into a good cattle-food.

It would evidently be a great economy if the pounding method were abandoned and, instead of it, small mills could be established all over the rice tracts.

We may conclude from this brief survey that, although our paddy exports must naturally come to an end some day, yet they may be maintained for many years still, not by the extravagant method of increasing the paddy acreage, but by increasing the acre outturns, and by reducing to a minimum the various losses that occur. It is only by some such means that the paddy tracts can be rescued from their present prodigal courses, and converted into regions of more respectable, more permanent and more self-supporting agriculture.

THE PRODUCTION AND MAINTENANCE OF PURE SEED OF IMPROVED VARIETIES OF CROPS IN INDIA.

By ALBERT HOWARD, M.A., A.R.C.S., F.L.S.,

Imperial Economic Botanist,

AND

GABRIELLE L. C. HOWARD, M.A.,

Personal Assistant to the Imperial Economic Botanist

A general consideration of the agriculture of the Indian Empire discloses the fact that the growth of crops is of far greater importance than any other aspect of this great subject. Not only for internal consumption, but also for the production of raw material for the export trade, almost everything else in Indian agriculture is subsidiary to crop production. Essential as cattle are to the country, it must be conceded that the ox derives its position from the fact that it furnishes the power necessary for cultivation and for the transport of crops. Plant production in India is of greater importance than animal production. This is reflected by the amount of attention bestowed by the Agricultural Department on questions relating to the improvement of Indian crops compared with the comparative neglect of questions relating to the livestock of the country.

The necessity for the production of improved varieties of the staple crops has been for some years recognised in India. With fuller knowledge of local conditions an increased and increasing amount of attention is being paid to this subject by the Agricultural Department. In many tracts crops new to the district are being introduced, better varieties of existing staples

are being brought to the notice of the people, coupled often with improved methods of cultivation. These efforts have brought to light some of the difficulties inherent in the subject and have created problems of organisation which now await solution and which, it is believed, will prove of interest outside India.

The whole question of the production and maintenance of pure seed of improved varieties of crops was one of the matters placed on the agenda of the last meeting of the Board of Agriculture held at Pusa in November, 1911. It was referred to a Committee of the Board, the report of which is given in full below. The terms of reference were as follows:—"To report on the most suitable methods for the production and maintenance of the supply of pure seed of improved varieties of crops with recommendations as to the best organisation for carrying out the same." The report of the Committee was accepted by the Board and will, it is expected, form the basis of future work in this direction in India.

Report of the Committee.

"The Committee consider that the *general aim* to be kept in view in the improvement of crops in India is the replacement, wherever possible, of the existing mixtures by pure types characterized by increased yield and by improved quality.

I.—Methods of obtaining improved varieties.

The Committee strongly emphasise the necessity of all work in this direction being based on a study of the methods of pollination of the various crops investigated. It is especially necessary in the case of plants which cross-fertilize that this preliminary work be undertaken, otherwise much time and energy may be wasted in selection experiments and in variety trials which cannot possibly yield any useful result. It is desirable further that this initial work be conducted in the tract concerned as several cases have recently occurred in which climate has considerably modified the usual pollination mechanism

For example, wheats cross to a far greater extent in the irrigated tracts of the Punjab than in the damper regions of India.

Selection.—In the case of self-fertilized crops the comparison of the progeny of single selected plants may easily result in the production of the desired improvement. In this case all that is necessary is to multiply the type and begin the work of seed distribution. In the case of plants which cross-fertilize, the procedure is not so simple, and special measures are necessary to avoid the consequences of vicinism.

Introductions.—In introducing varieties of crops from other tracts or countries it is necessary in the first place to study the constitution of the crop and to apply when necessary methods of selection. The immediate distribution of imported seed is undesirable owing to the possible prevalence of inferior types. Neglect of these precautions in the past probably accounts for the want of results in introducing exotic cottons into India.

Hybridization.—If the desired improvement cannot be obtained by selection, it may be necessary to cross suitable types and to evolve a new form combining the special characters desired.

Work on the above lines should result in the production of a stable agricultural type which alone should form the basis of future seed distribution.

II. The testing of varieties.

"In the testing of varieties of crops which cross-fertilize there are special difficulties to be borne in mind. The seed of different varieties grown side by side cannot be employed for the production of pure seed. For the same reason variety trials should not be conducted on seed farms unless special precautions are taken to isolate the plots from which the pure seed will be derived.

III. The maintenance of pure types.

"The Committee lay great stress on the maintenance, by the Botanist in each Province, of a collection of the improved types

introduced into general cultivation by the Local Department. This collection will serve as a source from which pure seed can be obtained whenever it is necessary to restock the seed farms.

IV.—Distribution to cultivators.

"The Committee are of opinion that the following main principles should guide the work of the Agricultural Department in the growth and distribution of seed to cultivators in India. These are :—

1. The desirability of concentrating the efforts of the department on one or two well-defined problems at a time rather than wasting its resources on indiscriminate seed distribution.

2. The desirability of confining the work of seed distribution in any one tract as far as possible to *one* sort and of systematically replacing existing mixtures by this pure type. This is particularly necessary in the case of cross-fertilized plants where degeneration through vicinism is of such great importance. The distribution of one sort only has the further advantage of creating large supplies of one particular type and thus forming a trade centre for this produce and attracting buyers.

3. The necessity of utilizing to the utmost the present staff and resources of the department and of supplementing this by enlisting the assistance of leading agriculturists in the work of seed growing and seed distribution in the tracts concerned.

Applying these principles to the present projects in India, it was felt that Madras and the Central Provinces supply the most useful examples of successful seed distribution which deserve the closest possible attention on the part of all concerned in this work.

Among the successful schemes of seed distribution in Madras the replacement of the mixed crop by a pure Karungani cotton in the Tinnevelly District is a notable achievement. This variety, originally found in a pure cotton tract, was tested on the Koilpatti Farm and proved to be a great advance on the

local mixture. A system of seed distribution was then gradually built up, and, at the present time, after five years' work, there are 80,000 acres of this cotton in the district. The agricultural farm grows sufficient cotton to supply the contract seed growers and buys the unginned seed from these men, gins it and arranges the distribution of the seed to the village depôts before the sowing season. Each depôt supplies two or three villages and a suitable man is selected as the depôt keeper who retails the seed under departmental supervision at a fixed rate and on a commission of annas four per bag. The village is regarded as the unit and every effort is made to get all the growers in each village to take up the seed. It is important to notice that the procedure follows that of the best seed growers in Europe and that the seed grown by the contractors is under strict control and comes back to the department every year.

In the Central Provinces, equally striking examples are furnished by the Agricultural Department. In the cotton tracts the work of seed distribution is confined to two suitable kinds, and a fairly large supply of seed is produced on the Government farms which is distributed to private seed growers who themselves retail their seed to the cultivators. In the wheat-growing tracts of this province, the efforts of the department are concerned with distributing a pure soft white wheat to selected *malguzars* who are members of the District Agricultural Associations. Each man agrees to sow a large area and to provide suitable arrangements for storing the seed and threshing the crop. In this way it is expected that beginning from a central farm a gradually increasing area of the wheat tract will be sown with one wheat only to the great advantage of the growers and the trade.

The main features of the above examples are that seed distribution starts from a central farm and gradually spreads outwards. The assistance of the best farmers is enlisted, the seed is fully charged for and the work is conducted in tracts where markets already exist for the produce.

In concluding its recommendations on this portion of the subject the Committee desire to draw attention to the desirability of some botanical control in the work of the central seed farms, and suggest that, whenever possible, these should be visited by the Botanist. The Committee also wish to emphasise the need of great care in seed-growing both as regards cultivation and also as regards contamination from such sources as the seed of a previous crop, manure, irrigation water and the like.

V.—Marketing the Produce.

"The Committee desire to mention the importance of this subject in the work of seed distribution and especially where distinctly improved crops are being grown. It is felt that, at the beginning at any rate, it is not possible for the people to get the real value of their produce and for the improvements to be fully recognised by the trade. At present quality by itself is sometimes a secondary consideration, but if combined with yield, the chances of successful introduction are greatly increased. The need is felt of some means of finding the real market value of the produce, and it is suggested the best way of doing this is to send to the best market and sell for several years there sufficiently large consignments of the produce.

In carrying out experiments of this nature, however, three points must be remembered :—

(1) That a single consignment in a large market or exchange is unlikely to attract much notice unless special attention is drawn to it.

(2) That single occasional consignments do not fetch the same price as produce of recognised value known to be regularly obtainable in large quantities.

(3) That as in the future the marketing of this produce must be in the hands of the local buyers and agents, it is advisable, where possible, to enlist their help and carry on this work with their co-operation."

A. HOWARD,
Chairman of Committee.

PUSA,
November 23rd, 1911.

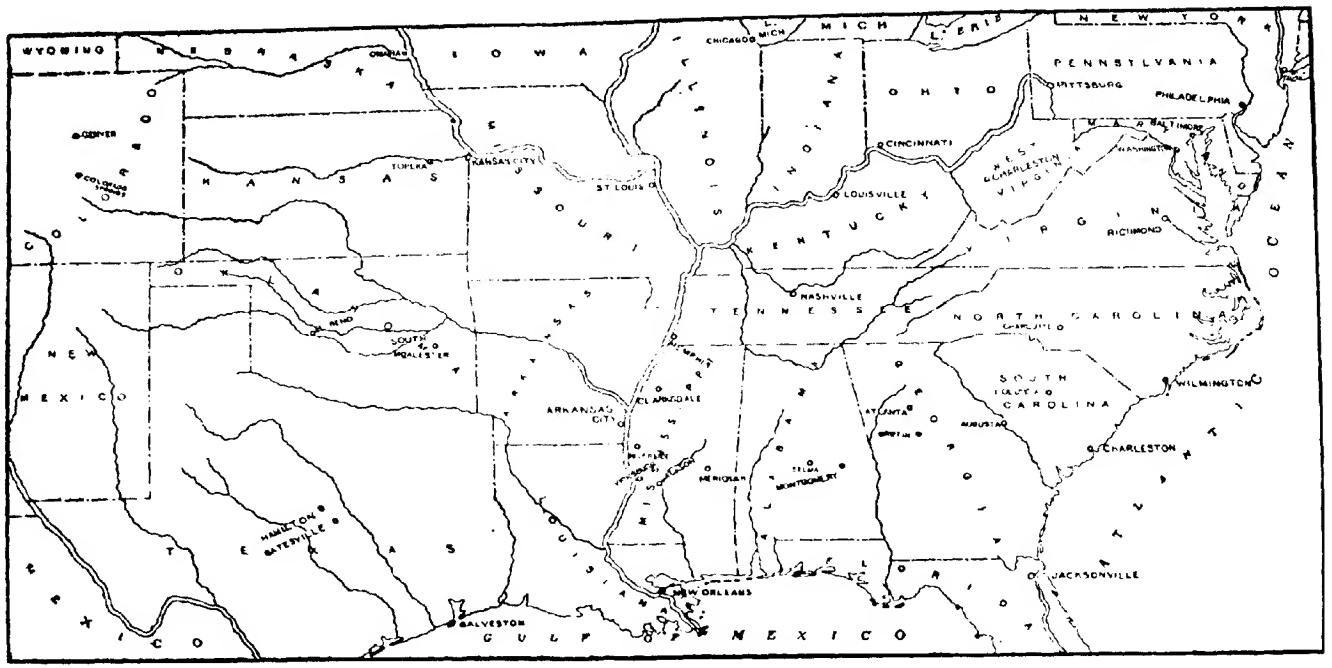
A study of the report brings out the supreme importance of natural cross-fertilization not only in the improvement, introduction and testing of varieties but also in the growth and distribution of seed to cultivators in India. Most of the difficulties inherent in the subject arise from the effects of vicinism, and it is this circumstance which, in the case of crops like cotton which cross-fertilize, renders the work of improvement so difficult.

The cotton crop is a good example for illustrating the part played by natural cross-fertilization in increasing the difficulty of bringing about a permanent improvement. Cotton is grown principally for the lint which in any particular tract should be uniform in such qualities as length, strength and fineness not only from field to field in any one year but also from year to year. If this condition is fulfilled, an area producing improved cotton will quickly establish a reputation for the supply of a product of known excellence. Such a condition of affairs as that indicated is unfortunately the exception rather than the rule in most cotton-producing areas and the crop is generally to a greater or less extent uneven in quality due to the effects of crossing between the various constituent types found in the cotton fields. To bring about a permanent improvement in the cotton crop in any tract in India is not an easy matter. Even after an improved sort is found, the difficulties in establishing and in maintaining the new variety are considerable. First of all, the merits of the new sort must be demonstrated to the growers and fully realised by them. Afterwards a system of seed distribution must be evolved to suit local conditions and which must come within the means of the Agricultural Department. The seed on the farms must be grown in such a way as to prevent deterioration through crossing with other kinds and its further distribution must be based on the principle that this new sort must entirely replace the old crop. The new cotton must be taken up by everybody in the tract, otherwise crossing will take place and mixing of seed will occur at the ginneries. Under Indian conditions all these stages must be supervised by the Agricultural Department

and the growers and all concerned must be made to understand the importance of maintaining the quality of the variety unimpaired. After a short time buyers will be attracted and the improved produce will find its real value in accordance with the laws of supply and demand.

In such an undertaking as the permanent improvement of a crop in India it is clear that no results can be expected at once. The work is one of time and necessarily involves an efficient organisation and sustained effort. In the first place, a clear conception of the problem as a whole and of the factors involved is essential to success. In the second place, an improved variety must be produced and then distributed by the best and quickest method to the actual cultivators. After some years it is probable that the new variety will maintain itself. Difficulties of course are bound to occur, new problems will arise which can most easily be met if the workers occasionally meet together and compare experiences. It is now generally felt in India that the biennial meeting of the Board of Agriculture furnishes a useful opportunity for the discussion of subjects of this nature and of developing a clear statement of the best policy to be adopted by the Agricultural Department and of the results obtained.

MAP OF THE COTTON BELT.



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UPLAND AMERICAN COTTON: BEING NOTES ON A TOUR IN THE COTTON BELT OF THE U. S. A., 1911.

By G. S. HENDERSON, N.D.A., N.D.D.,

Deputy Director of Agriculture, Sind.

i

The cotton belt of the United States of America comprises the following States :—

N. & S. Carolina	East of the Mississippi.
Florida	
Georgia	
Alabama	
Tennessee	
Mississippi	
Arkansas	West of the Mississippi
Louisiana	
Oklahoma	
Texas	

A little is produced in the Western States of Arizona, New Mexico and California, and in the N. E., in Virginia, Kentucky and Missouri. In California cotton is grown under irrigation, but in all other parts it is purely a rain crop.

It will thus be seen what a very wide range cotton cultivation occupies. If the price of the staple justified it, as a great area is suitable for its extended cultivation, the production could be greatly increased.

The original home of the cultivation is in the S. E. and it has generally extended from there westward. Texas is now the biggest producer and is followed by Georgia. Three States producing the long-stapled Sea Island cotton are Georgia, Florida and S. Carolina; this report deals exclusively with 'Upland' cotton, the term used to distinguish between Sea Island and the ordinary American Staple.

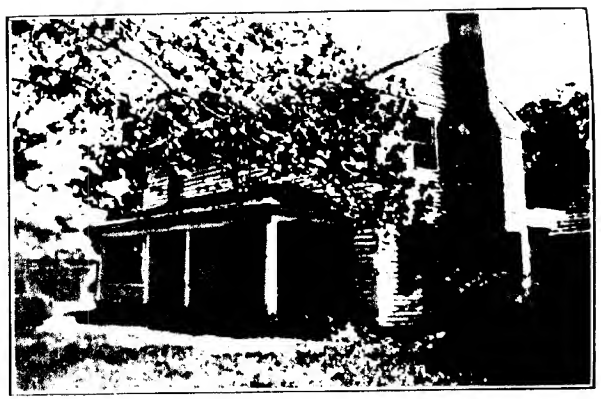
The yield in America in the last 10 years has varied from 9½ million bales to over 13 million bales; taking 500 lbs. to the bale, it is about 1 bale to 3 acres. The price in the same period fluctuated between 8 cents per lb. of lint to over 14 cents, or 4 pence to over 7 pence.

Upland cotton is the chief source of the world's cotton supply, Indian and Egyptian cotton following a long way behind. Indian cotton produces half the yield of American cotton per acre and the staple is much less valuable. Egyptian produces double the yield of American cotton per acre and the price has fluctuated between 7½ pence per lb. and 10½ pence.

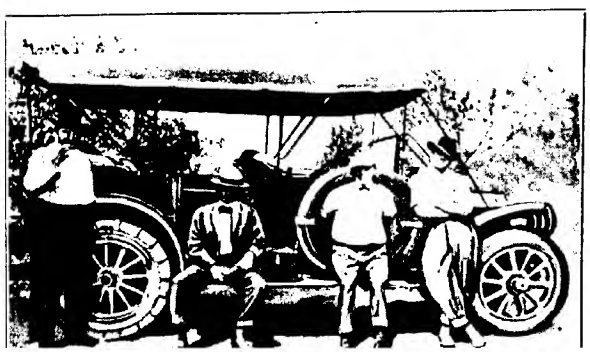
II

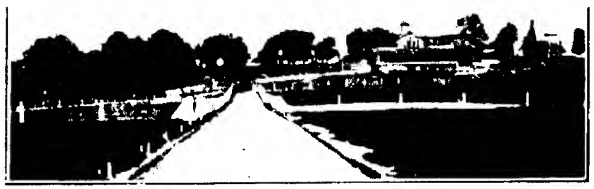
The following notes are based on a tour through the cotton belt in September and October, 1914.

After a halt in Washington, D. C., to see the head-quarters of the Department of Agriculture the route taken was through N. & S. Carolina. The cotton belt begins about half way through N. Carolina, and Charlotte is the centre of a thriving district depending on cotton. Through the kindness of Messrs Van Landingham, cotton brokers, a number of cotton fields were visited and farmers and others interviewed. The soil, generally, is a brick red colour and the country is broken and undulating. Through the east generally, banks are needed to prevent wash of soil from sloping ground. The season is short, and quick maturing, short-stapled varieties are cultivated and frequently heavily fertilised by artificial manures. The cotton plants are short and scrubby. King, Bates and Simpson are favourite varieties. The cotton farms are generally small and tenants.

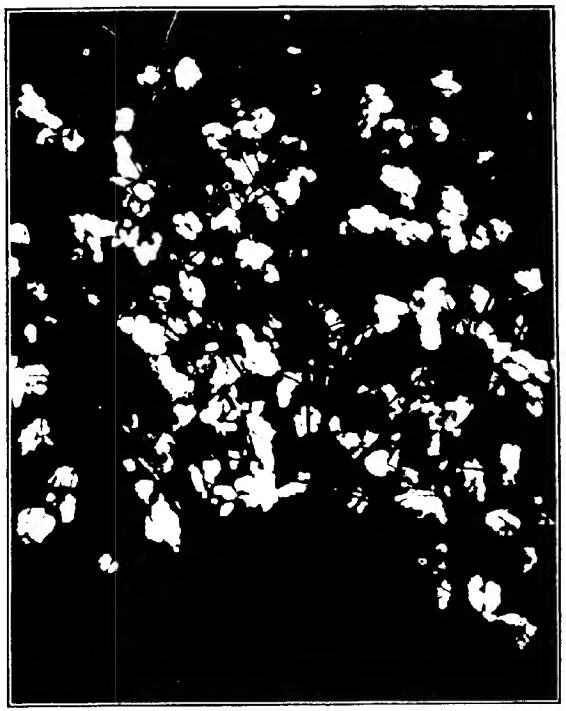


PALMHOUSE, CAROLINA.





Alabama State Farm, Auburn, View of Experiment Station.



Result of Seed Selection.

both whites and negroes, with a rent of half the yield, are engaged to cultivate land which the farmer cannot deal with.

Columbia was next visited. This is the capital of South Carolina. Mr. Lewton, in charge of cotton investigations of the U. S. A. Agricultural Department, was here met. The farm of Mr. Keenan was inspected. Here cotton selection has been carried out for 10 years. Seed from selected plants has been sown in separate rows, and a plant is again selected from a row and the seed sown in a separate row and so on year by year.

The object of the selection was to produce a long-stapled, large-branched and well-bolled cotton plant. His two varieties, "Columbia" and "Keenan" (the first from Russell's green seed and second from Pride of Georgia) look excellent material and are all bought up at a high price and distributed in suitable localities by the Agricultural Department.

From Columbia, Atlanta City, the capital of Georgia was the next stop, the way leading through Augusta. The state Department of Agriculture is situated at Atlanta with a farm at Griffin. The cotton crops along this district and the North-East generally are disappointing. The leading lights in the cotton world were gathering at Montgomery, the capital of Alabama, where a convocation had been called by the Governor of Alabama and the Commissioners of Agriculture for all the cotton states, to discuss problems in the estimation of cotton crops and in marketing cotton.

During the conference an opportunity was taken to visit Auburn, the Alabama State Farm, and the chief centre in the U. S. A. of experimental work in cotton. Variety tests on cotton have been going on here for a considerable period.

Meridian, in Mississippi, was the next city visited. The character of the country here begins to change. The soil is darkish in colour and densely wooded with oak and pine. Cotton plants are much higher and the growth is stronger. From Montgomery through Selma the land is generally held by big planters and worked by negro tenants. Soil and climate are more suitable

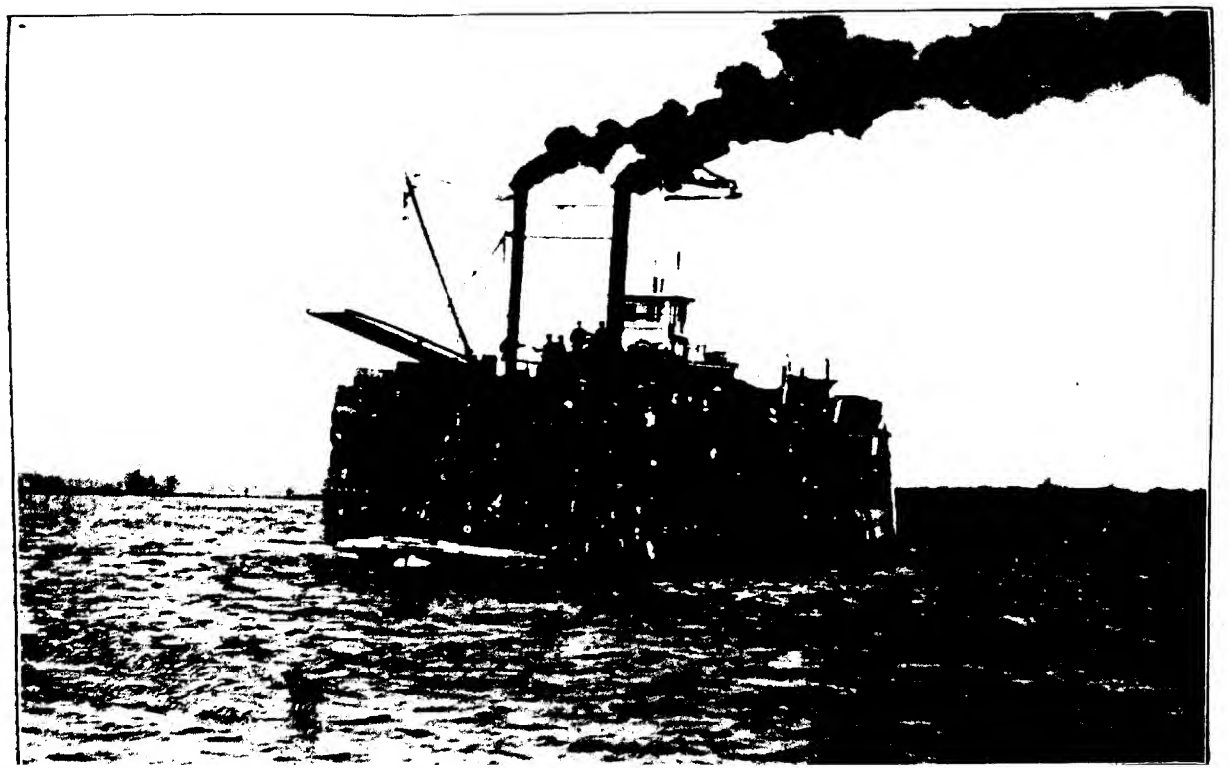
than in the N. E. for cotton, and it is only the devastation caused by the boll weevil in the S. W. that keeps cotton so largely cultivated in Eastern States. There fertilisation is required and land and labour are expensive.

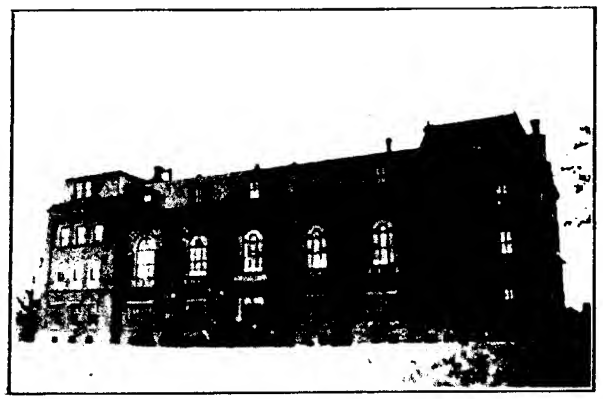
From Meridian the route taken was through Jackson to Vicksburg, a famous cotton mart on the Mississippi. Much of the stapled Upland American cotton was handled here and taken down the Mississippi to New Orleans by stern wheelers. Stapled cotton has length of fibre up to $1\frac{3}{16}$" to $1\frac{1}{4}$". 100,000 bales of stapled cotton used to be handled in Vicksburg a few years back: now the quantity is about half and none of it is staple, that is, it is less than $1\frac{1}{2}$" in length. The decrease is owing to the boll weevil which originated in Texas, gradually spread East and has now reached the borders of Alabama. An area of long-stapled and late-maturing cotton (Black Rattler was inspected near Vicksburg through the courtesy of Messrs. Compton Brothers, not a single boll could be found and the weevils, which were numerous, were eating the flowers and squares.

From Vicksburg the way lay through the famous Yazoo Valley along the left bank of the Mississippi past Riverside and Clarksdale. The weevil has not spread far North yet, and in the low-lying alluvial lands the cotton plant is seen at its best and could probably only be equalled in the southern area of the Egyptian delta. From Memphis, which is a big cotton centre on the Mississippi, a visit was paid to the Mississippi State coloured penitentiary, where a block of some 15,000 acres has been cleared of timber and 10,000 acres put under cotton by convict labour. There, by the courtesy of Mr. Terrill of the U. S. Lumber and Cotton Company, several of the estates of his company were inspected.

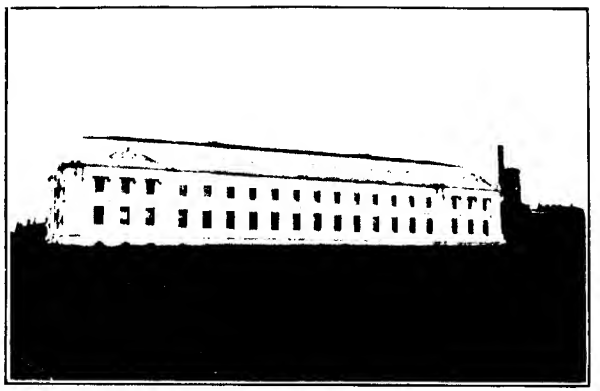
From Memphis the way lay through Arkansas and Oklahoma, by Little Rock, McAlester and El Reno where the cotton investigation ceased. After passing the Mississippi Valley the character of the cotton resembles that of the East again and large tracts of brick-red earth are seen.

PLATE XVIII.





Original Building, U. S. Department of Agriculture.



New Wing.

III.

The following notes were made on some of the chief points of interest seen on the journey.

United States Department of Agriculture.

This is situated in Washington. The original block of buildings now only suffices for the offices of the Secretary and Under-Secretary. A grant having been obtained from Congress for buildings, it was utilised in building two large wings of white marble, leaving the centre open for future building operations when more money will be available. The department overflows into various hired buildings in the city. The department has many administrative duties in addition to its ordinary work, in connection with veterinary and sanitation inspection, with the pure Food and Drugs Act, and with the legislation on plant diseases, etc.

The work is distributed under the various bureaus, which are again divided into sub-heads, according to the importance of the subject. The chief bureaus are :—

Bureau of Plant Industry.
Do. Animal Industry.
Do. Soils.
Do. Chemistry
Do. Entomology.
Do. Biological Survey
Do. Statistics.

There are also Divisions of Forestry and Public Roads.

In the Bureau of Plant Industry letters were obtained from Mr. Kearney in charge of the dry-farming investigation and from Mr. Lewton in charge of the cotton-breeding enquiries. Mr. Lewton is the chief authority on Indian cotton types in the department and he is experimenting with reference to their adoption in parts of the States where especially quick maturing varieties are required.

An interesting sub division is that in charge of Dr. Cobb, Cotton Technicology. An effort is being made to standardise the various empirical methods of grading and valuing cotton at

present used in the trade. Sets of the different grades of cottons have been prepared by commercial experts; copies of these are carefully made, for distribution to chambers of commerce and cotton exchanges. In order to perpetuate these grades which have now been made legal by special Act of Congress they are wrapped in black paper, to preserve from light, put in glass cylinders protected top and bottom with asbestos, air exhausted, and the glass ends sealed under the blow-pipe.

Actual measurement of cotton fibres is made by projecting them on to a screen under a certain magnification by a lantern. These lengths are measured off the screen by a map measurer and the result calculated on calculating machines. This is repeated till a fairly constant figure is obtained. It is found that commercial experts generally put the length of staple too high.

Cotton Selection on Mr. Keenan's Farm, Columbia.

From work extending over 10 years Mr. Keenan has produced 2 excellent types of cotton, 'Keenan' and 'Columbia.' The staple is nearly $1\frac{1}{2}$" long. The first was selected from 'Russell's green seeded,' but as the colour was considered a disadvantage, plants with green seeds were eliminated and now no green seeds occur. The type of plant required was of good size and strong-growing, branches to be strong and from near the root head, bolls spread over the plant and not clustered, bolls to have 4—5 sutures and not pointed or flat-sided, 40 to 50 bolls were required on a plant of such a size that 50 bolls would produce 1 lb. seed cotton. Early maturity was also sought after. It was also recommended that the stigma of the flower should be short and light yellow, thus probably giving less chance of cross-fertilisation. Plants not according to this type are at once rogued. The sowing for the next year is done from specially marked plants, having one row for each plant. The rows are all numbered and the derivation of any plant can at once be obtained. The remainder of the crop each year gets a high price for seed. The importance of a system of selection was very evident from a comparison with neighbouring crops.

Alabama Experiment Station, Auburn.

The experimental area is about 35 acres, and valuable work has been done in collecting all varieties in cultivation and recent introductions, and classifying them. Selection work is largely carried out. Cook is the favourite variety, along with King. Other crops dealt with are corn, cow peas and soy and velvet beans. Rotations are recommended to cultivators in place of continuous growth of cotton.

Cotton Convention at Montgomery (Al).

Some 600 farmers, cotton producers, bankers, merchants and others interested in cotton and all the cotton states' agricultural department's officers met in order to devise ways and means for getting a hold on the cotton crops and prevent the price being run down by attacks of market bears. This was the initial movement of the kind, and though it did not accomplish much, yet it showed that combination among producers was possible. It will probably prove the beginning of a strong movement, and enable a gradual marketing of the crop, when prices are favourable.

Various proposals were before the meeting, such as the establishment of state bonded warehouses where all cotton should be deposited. Money could be raised on warehouse receipts for deposited cotton and this would enable the producer to keep on till he got a satisfactory price.

The feeling of the meeting was against the United States Department cotton estimation for the year. This was 14,000,000 bales; the Convocation resolved that this was 1½ millions in excess.

Operations of the U. S. Lumber and Cotton Company.

This is a company, financed from the North, which has taken up land in the Mississippi Valley and in Georgia. They have some very fine properties, well situated as regards transport facilities, under cotton, and others just being cleared of lumber

Their operations are typical of what is generally taking place in this district, where outside capital is acquiring the large tracts formerly owned by the old Southern families. The Yazoo Valley, as the land between Memphis and Vicksburg, and bounded by the Mississippi on one side and hills on the other is called, has always been famous as a cotton district. Even before the Civil War it was the ambition of every Southern planter to own an estate here. Before the boll weevil era stapled cotton spread over to Louisiana and the East of Texas, but is now quite given up. The Yazoo is now the only source of supply. The old trade name 'benders' originated here; on the opening up of the country cotton was first cultivated on the alluvial bends of the river, and cotton brought in from the East improved in staple after planting here for a few years.

The first property visited was Hillhouse, consisting of about 12,000 acres right on the Mississippi. A branch railway runs through and it owns its own riverside quay. Corn is grown as food for mules and is also eaten by the negroes. Cow pea is sown among the rows and climbs up after the cobs are pulled off the corn stalks. They are cut combined, as required, and make good feed. The rest of the land is under cotton continuously, little rotation being practised. Each negro tenant gets 20 acres; mules belong to the Company. There is a central store on the property in which is supplied everything from 'fancy notions' to meat and bread. The tenant gets credit at the store up to 60 cents per acre per month. This is squared up along with the rent at end of cotton picking. The rent is generally fixed to obtain half the outturn. Much of the land yields 1 bale to the acre year after year without any fertilizers.

Another property visited was Lake View, where the land was being cleared and put under cotton. Both these places have their own gins and railway sidings.

The British Fine Cotton Spinners Association have bought a property near the Mississippi; it is thought that it is in the danger zone of the boll weevil, though this pest is not going

Cotton 9lbs. high.

First Crop Cotton on cleared land, Lake View.

North nearly so fast as East. The price of this property, $100 per acre, is certainly low for 'made' land of such quality, and similar land could certainly not be obtained in Egypt at the price.

IV.

Varieties and Grades of American Cottons.

Professor Dugger of Alabama has put forward the following useful classification of varieties of Upland Cotton plants:—

1. Cluster.
2. Semi-Cluster.
3. Naked Seeded.
4. Short Limbed.
5. Big Boll.
6. Long-Stapled Upland.

1. *Cluster.*

Plants tall and erect with no limbs at base, bolls clustered round main stem.

Type—Dickson.

2.—*Semi-Cluster.*

Plants tall and erect with base limbs, moderate length bolls more or less in clusters.

Types Peerless
Hawkins
Boyd Prolific.

3. *Naked Seeded.*

Plants well branched and medium in size. Seed black and bare of fuzz. Percentage of lint large.

Type Peterkin.

4. *Short Limbed.*

Plants small and branched top and bottom. Bolls small, numerous, early maturing.

Type—King.

5. *Big Boll.*

Plants large and strong with big branches from near root, bolls very large and seed big, sometimes mature late.

Types—Russell.
Texas Big Boll.
Triumph.

6.—*Long-Stapled Upland.*

Plants big and inclined to be straggling, with long branches. Bolls long, pointed and tapering, generally flat-sided. Staple good, with percentage of lint low, generally under 30%, late in maturing.

Types—Allens.
Cook.
Doughty
Griffin.
Black Rattler.

These distinctions are important, especially when looking for a suitable variety to introduce into India. The work in Bombay has been chiefly with the Big Boll and Long-Stapled Classes.

American cotton is graded and sold in the markets in the following classes:—

I—Fair.
II—Middling Fair
III—Good Middling
IV—Middling
V Low Middling.
VI Good Ordinary
VII—Ordinary.

These are divided into half grades by putting the word 'strict' before the name of the lower grades, as strict middling fair. The quarter grades, not much used, are distinguished by the prefixes 'barely' and 'fully.' Middling is the grade indicated in all cotton contracts and specialities. The grade depends

on the colour of the cotton and amount of trash contained in it. It is not dependant on the length of staple.

To classify cotton needs a great deal of experience. Cotton firms would only allow men out to buy after 3 or 4 years' experience in the warehouses, and then only entrust them with special growths and small quantities.

V.

Cultural Methods of Cotton Crop in America.

The ground is well ploughed, in winter if possible and otherwise in spring, and a good tilth obtained by harrowing and cultivating. Then a row is opened, often with a double mould-board plough and the manure put in it, but this may be done in the operation by a fertiliser drill. The next row is opened along side of this at a distance of 3 to 4 feet, and so on with the whole field. The space between the drills is then ploughed, generally 3 times up and 3 times down, leaving the 'blind' furrow in the middle between two rows. So between each furrow is low ground where the fertiliser was placed, is high, having the earth heaped up from both sides. On this ridge the cotton seed is sown by the drill or 'planter' which is noted later. The space between the plants is cultivated while the latter are growing up, by horse-hoes or 'scufflers.' As the plants come up too thick in the row, they have to be chopped out or thinned with the hand hoe. They are left at a distance between plants of 12 to 16 in poor soils, and 20 to 24 in good soils. The horse-hoe is used in the row till the plants get too high. Picking is done by contract and is expensive, about 60 cents per 100 lbs of cotton. It begins about September. Cost of picking often comes to 1/3 the value of the cotton. In India cotton can be picked for 1/4th the weight brought in by the pickers.

Fertilisers are refuse from cotton seed-crushing mills and sometimes artificials. Compounded manures are often made up to the formula 8 per cent. Phosphoric acid, 2 per cent. Nitrogen, and 2 per cent. Potash.

Rate of sowing varies with the planter or drill used. Time of sowing is end of April and May, but is earlier in the West. It is sown up to first week, June.

The method of making ridges and the distance apart of the ridges is quite different to that used in Egypt, and cotton in America is invariably planted much wider apart than in Egypt and in India.

In Egypt rows are made 18" to 20" in one operation by the double mould-board plough or what corresponds to it, and plants are thinned to about 6" to 8" apart in the rows. The ridges are also higher.

In America it is generally considered that with fertilisers and picking and all other expenses it costs $25 to $30 to raise an acre of cotton.

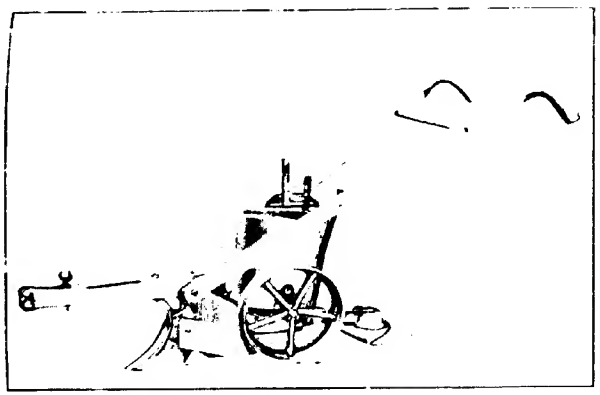
VI.

Implements and Cotton Machinery.

The planter or drill is an important implement. The Cotton Planter as illustrated is an efficient implement. The force-feed is fastened on the steel axle with the drive wheels and the seed is distributed evenly. The quantity of seed is easily regulated from 2 to 8 pecks per acre (*i.e.*, from 25 lbs. to 100 lbs.). It is hauled by one mule or ox. The price in America is $7.50 or Rs. 22-8-0. Other patterns of the planter are available with attachments for sowing artificial manures.

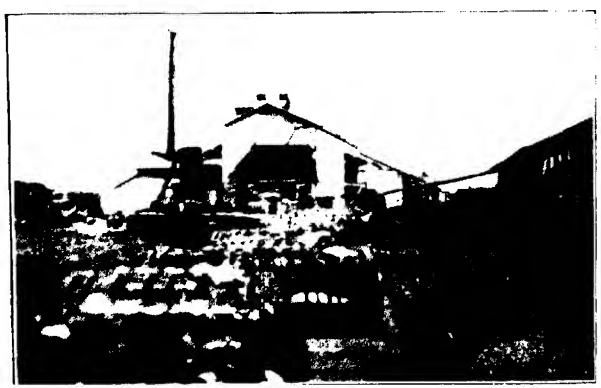
There is nothing particular about the other implements used in cotton cultivation.

The gin, however, invariably used, is not the hand fed single roller gin of India and Egypt, but the saw gin. Large properties have their own gin and compress, and there are a large number of gins for hire work at rail depôts and other central situations. These latter gin-owners do not usually buy the cotton, the farmer often brings his cotton loose in a square box waggon containing about 1,500 lbs. and gets back a 500 lbs. bale of cotton. He sells this at the market and the gin owner generally buys the seed.



The Cole Cotton Planter.

Private Gin and Press.



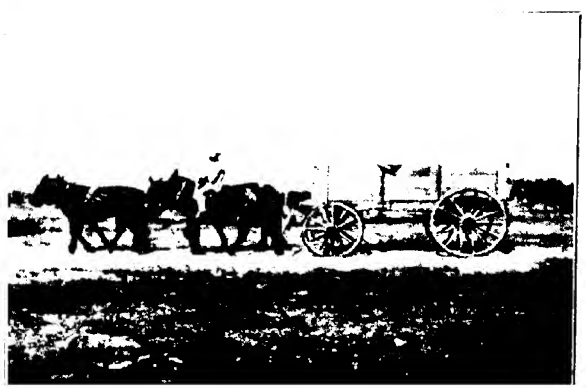
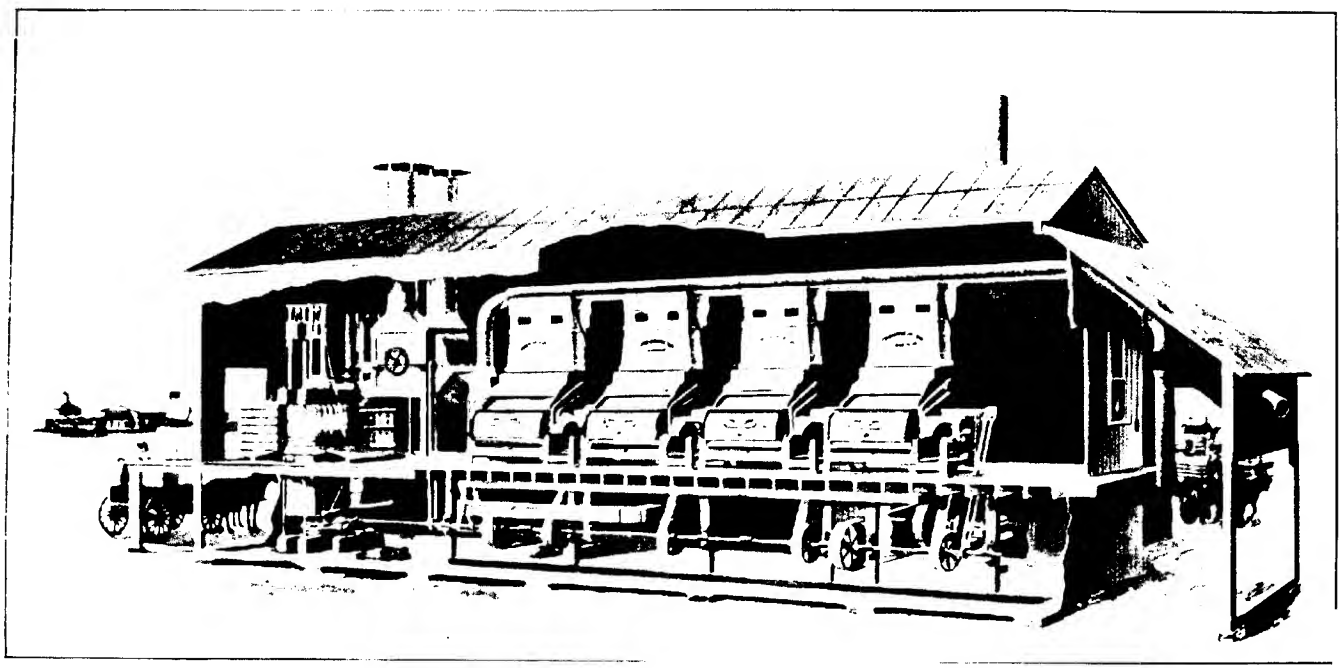


PLATE XXIII.



OUTFIT OF COINS, PNEUMATIC ELEVATOR, CONDENSER, AND DOUBLE BOX PRESS.

In the saw gin the cotton is separated from the seed by rows of steel discs, with serrated edges like a circular wood saw. The seed cotton is held in a box in which is a grate of steel ribs. The teeth of the discs engage the fibre and pull it from the seed which is too big to come through the grate. A roller having small bunches of steel wire on its surface, called the brush, cleans the fibre off the teeth of the discs.

The ordinary bale measures $4' \times 2\frac{1}{2}' \times 2\frac{1}{2}'$ and is covered with "gunny" cloth. It is fastened with 8 steel bands.

The illustration shows a modern outfit of 4 gins. The cotton is elevated from the waggon and distributed to the feeders by suction. Cotton is cleaned before entering the gin. After ginning, lint is blown from the brushes, through a flue, to the condenser. The dust passes through the roof by dust flues. In the condenser the lint is blown against a drum covered with a wire screen; thus air and fine dust are taken out of the lint. The drum forms the cotton into a smooth and continuous "bat" which is then fed to the press, packed by an automatic tramper and baled. The seed is blown into a "godown". A 2-gin outfit of this type having 80 saws each was seen working. It worked very smoothly with very few hands and turned out one complete bale each 15 minutes. The cost of ginning and packing at public gins, covering not supplied, is from 81 to 82 per bale. In Sind the gins asked Rs. 12 per 1,500 lbs. seed-cotton = 84.

The cotton picker is not yet a practical machine. One was seen working; it had flexible suction tubes which had to be directed to the bolls by hand. The motive power was an oil engine, the whole was mounted on a truck drawn by 2 mules. After picking, the cotton was conveyed to a gin arrangement also on the truck. The opinion of spectators was that it required a considerable amount of improvement.

VII.

Insect Pests and Diseases of American Cotton.

By far the most important insect pest is the Mexican cotton boll weevil (Anthonomus grandis). This has caused immense

damage in America, and it is steadily spreading East at the rate of about 70 miles a year. It spread through South Texas and Louisiana, and it is now well through South Mississippi and has touched Alabama. It hibernates in the ground during the cold weather. Eggs are laid in early spring, and there are a constant succession of generations till frost. The only chance of getting any cotton, in an affected district, is by planting an early maturing cotton, and even then it will probably only be the bottom bolls from which any cotton will be obtained. There seems to be no effectual means of getting it under control. When it comes into a district, there is at once a migration of negroes: they go off with their mules and implements. The land will, of course, grow other crops, but there is no machinery for dealing with these for the first few years. For example, the farmers round Vicksburg were complaining that there were no markets near to dispose of the corn or 'truck' crops.

If ever this pest got into India or Egypt, it would do immense damage. The danger is in importing seed cotton.

The cotton worm or army worm (Aletia argillacea) was found in considerable numbers in parts of the cotton belt. It eats the leaves, and, in September, fields were seen entirely defoliated. Spraying with arsenate of lead seems to be very effective.

A considerable amount of Anthracnose (Colletotrichum gossypii) was noticed. It starts as a black spot on the boll, which gradually spreads till the whole boll rots away.

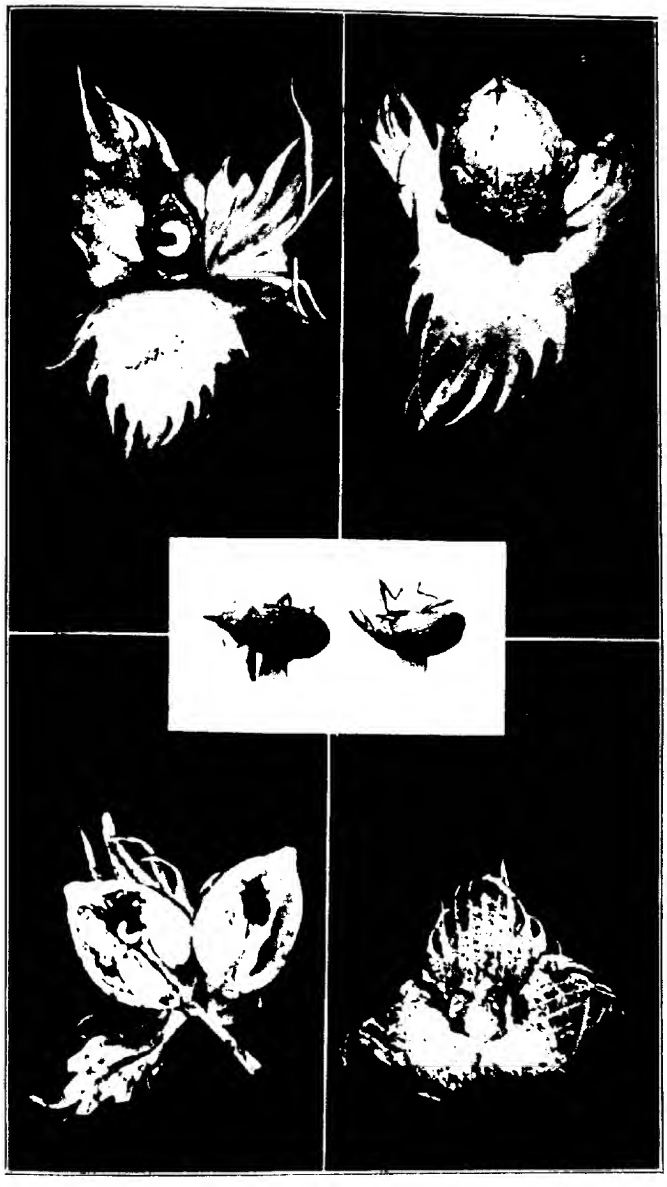
Boll worm is always found, but not much complaint was heard about it.

VIII.

American Cotton for India.

In parts of India where cotton is cultivated as a rain crop, and where moderately good cultivation obtains and where it is found that 'Upland' cotton flourishes, it will be possible to cultivate it in a more or less similar manner to that found in the States. The important points are to begin on a good variety with a suitable staple, and most important to sow it wide apart

PLATE XXIV.



It would be advisable to use the American drill or planter and to sow it in rows from 3–4 feet apart and with plenty of room between plants.

In Sind conditions are different. Cultivation depends on irrigation canals. Egyptian cotton was found to succeed where it could be sown in March and April, but there was only one canal where water was available. It has a longer growing period and the cultivators would not take the extra trouble it required, but preferred the hardier Sindhi native cotton.

The cultural methods for Sindhi cotton are simple: after an irrigation, when the land will bear cattle, cotton-seed is broadcasted on the surface, and the ground is lightly ploughed to cover the seed. Thereafter, the only attention given is a hand-hoeing when the weeds get big, and the necessary waterings not less than 2 per month.

Consequently, any introduction, to have any success, must be made to be cultivated very simply. The irrigation canals in Sind, fill on the rise of the Indus and water is available about the beginning of June. Good samples of various varieties of Upland have been raised in all parts of Sind, sown in beginning of June. The outturn per acre has been little if any less than the local Sindhi, but so far it has never been sown thick. It does not, however, suit light sandy and Kalrishi or Alkali land.

At present buyers fight shy of the produce, as they have no experience of its commercial value. Arrangements have been made for buying agencies, in order to get the full market price of the staple. The area of Sind is about the same as that of Egypt. It is only recently that cotton has been cultivated to any large extent. It is at present confined to the South in an area of between 300,000 and 400,000 acres, and the outturn last year was about 170,000 bales of 392 lbs.

The method to be recommended to zemindars (land-owners) will be as follows:

After irrigation, rows will be run across the field with the native plough, 3' apart. Immediately behind the plough, cotton seed will be dropped, by hand, at the rate of about 30 lbs. per

acre. This gives a moist seed bed. After the plant germinates between rows will be occasionally ploughed: this will be cheaper than a hand-hoeing, and the native plough does not go deep enough to damage the roots. Excess of plants in the row can easily be chopped out by 'kodar' or hoe. No ridges will be recommended as they would not likely be viewed with favour by the ordinary cultivator. Seed can be obtained from the State for the first year or two, and a seed-farm for supplying good seed will be arranged.

Boyd Prolific ...
Texas Big Boll ... } are the varieties at present being grown.
Triumph ...

The difficulty will probably be to get the cotton picked moderately clean. In the hot dry atmosphere dust and broken leaves are difficult to keep out.

The saw gin will probably prove more economical and efficient for dealing with Upland cotton, but this can be considered in the future.

RICE CULTIVATION IN TRAVANCORE.

By N. KUNJAN PILLAI, M.A., B.Sc., Ph.D.,

Director of Agriculture, Travancore.

RICE is the most widely cultivated crop in Travancore. The total area of the State is 4,558,240 acres, of which 1,200,000 acres are under cultivation, and of these more than 500,000 acres are under rice. In spite of this proportionately large area devoted to the cultivation of rice, the local production falls far short of the requirement of the people. In the year 1909-1910 the value of the imports of rice into the State amounted to Rs. 74,22,240, while in the previous year when there was a partial failure of crops in some parts of this State the value imported went up to as much as Rs. 1,58,51,890. In Travancore, as in other countries, the population is steadily increasing. In 1901 Travancore had a population of 2,952,157 and by 1911 it had become 3,430,251. In the face of such a large increase in population and in the absence of fresh lands for the cultivation of rice, it is only natural that the imports of this food grain show a steady increase from year to year. The only way of checking these imports is to try and enhance the outturn from the existing area under rice by the adoption of up-to-date scientific methods of cultivation, which till now remain outside the ken of the majority of Travancore ryots. The average yield of rice per acre in Travancore is so ridiculously low that there is no doubt that by the introduction of improved methods of cultivation the yield can be doubled and even trebled. A move has already been made in this direction by the organization of a Department of Agriculture in the State three years ago, and through the activities of this Department a general

awakening has been aroused throughout the State in agricultur improvement. I hope to contribute, on another occasion, a pap on the lines of work followed by the Department and t improvements that have been introduced through its influenc In this paper I wish to confine myself to a description of th peculiar features of the methods of rice cultivation indigenous t the State.

Climate.—Travancore occupies the south western portion the Indian Peninsula and is situated between 8° 4′ and 10° 22′ Nort Latitude and between 76° 15′ and 77° 38′ East Longitude. Th temperature ranges between 70°F. and 90° F., the mean da temperature of the year being 80° F., and the mean maximum the year being 87·5 F. The heat from February to May intense, and during this period there is a lull in agricultur operations.

Rainfall.—The rainfall in the State is fairly well distribut over seven or eight months of the year, the downpour being ver heavy during the two monsoons (June July and Octobe November). The annual rainfall varies from about 30" to abo 150", the fall increasing progressively from the south to th north, and from the coast to the hills.

Irrigation.—In spite of the large variation in the quanti of rainfall, rice is cultivated in all the available lowlands throug out the State. In the southern parts, where the rainfall deficient, the crop is raised with the help of irrigation, whi in the north, where the fall is excessive, the water has very ofte to be drained away to ensure successful crops.

The necessity for irrigation in South Travancore was recognised even in very ancient times, and through the foresight of th then rulers a large number of irrigation tanks were dug, seve of which are about 1,000 acres in extent. These tanks ha been in existence from time immemorial and have been t recently the chief source of irrigation in South Travancor Owing to the scarcity of the rains the storage of rain wat in the tanks was not, however, sufficient to meet the dema for irrigation, and consequently a dam was constructed acr

ne of the chief rivers in South Travancore about a thousand years ago, and later on another dam about a quarter of a mile lower down the same stream. The water from these dams was led into the irrigation tanks by a network of channels, carefully and ingeniously laid out by the ancient engineers who, though lacking in the technical training of modern engineers, abounded in practical wisdom and skill. With the facilities thus afforded for irrigation, a large tract of dry and desolate land depending entirely upon deficient and irregular rainfall for its cultivation, was converted in course of time into a prosperous agricultural district, rightly called the "granary" of Travancore.

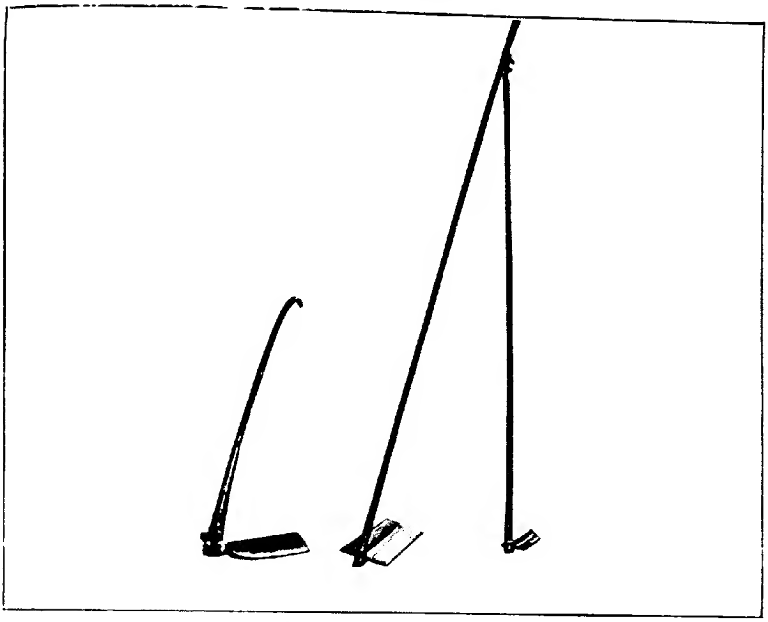
In spite of the vast improvement effected in the irrigational system in South Travancore from time to time, the water-supply continued to be precarious, and the change of crops was not, therefore, an uncommon phenomenon until the completion of a more comprehensive scheme of irrigation a few years ago. This scheme was for the utilization of the Kothayar, a river with a copious supply of water, for irrigation purposes, by the construction of a mighty dam and several channels. The first attempt in this direction seems to have been made early in the nineteenth century, but without much success. A regular investigation of the scheme was started by Colonel Ouchterlony and Captain Horsley, about the middle of the nineteenth century, and since then the question has been taken in hand and expounded by several engineers, many of whom pronounced favourably on the scheme. The Durbar naturally hesitated for a long time to launch such a stupendous and costly irrigation project. At last in 1896 it was finally decided to carry out the work, and the construction of the dam was accordingly started in that year. The dam was completed in 1905 at a cost of 11 lakhs of Rupees, the main channel and several of the subsidiary channels were finished by the middle of 1907, and water was let down these channels for the first time in 1908. Some important subsidiary channels are still under construction, and with their completion it is estimated that the total expenditure on the Kothayar Project will come up to nearly 70 lakhs of

Rupees. The project is designed to irrigate about 34,000 acres of existing wet lands and about 25,000 acres of dry land to be converted into wet, and is expected to give the Durbar a net return of Rs. 2,31,250 per annum for the time being.

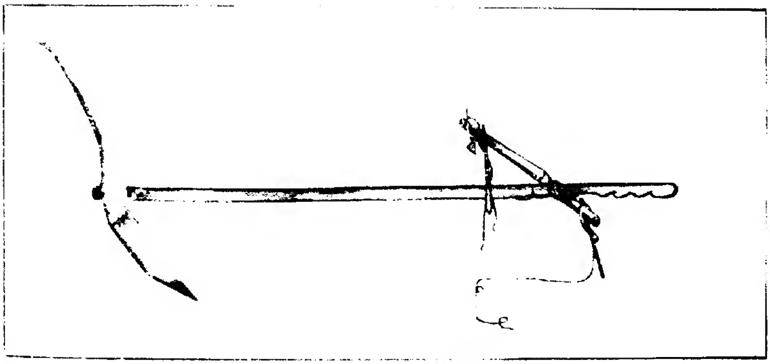
So much for irrigation in South Travancore. In other parts of the State there is no irrigation worth mentioning. In North Travancore the rains are so abundant that the crops suffer more from excess than from deficiency of water and very often the excess water has to be drained away to save the crops. In Central Travancore the rains are moderate and would suffice for the successful raising of rice crops if they were evenly distributed during the cropping seasons. More often than not, however, such an even distribution fails, and the crops consequently suffer unless artificial means of irrigation are resorted to. Partly owing to poverty, partly to ignorance, and partly to the laziness of the ryots, such irrigation is very rare in Travancore. Here and there the water-wheel (it resembles the Persian wheel) and the bailing basket may be seen in use during seasons of drought. The *picotah*, the *ahate* and other forms of simple water lifts that are so common in the adjoining British territories have not yet come into vogue in Travancore, and oil engines and centrifugal pumps, which are strongly recommended by Mr. Chatterton of Madras, have not yet found their way into this State. It may be expected, however, that as a result of the awakening that is seen among the ryots in agricultural improvement, such of them at least as can afford the necessary expenditure will ere long see their way to the installation of some of the water lifts mentioned above, and particularly oil-engines and centrifugal pumps, in places where conditions are favourable.

Agricultural implements.—The agricultural implements commonly used in Travancore are not many. They are simple and primitive, and are made by native carpenters and blacksmiths, of whom there are a few in each village. The plough, the yoke, the *nattom* (levelling rod), the spade, and the *thumbu* (hand-hoe) form the usual stock-in-trade of farmers in the State. The plough usually consists of two pieces of wood fixed together by

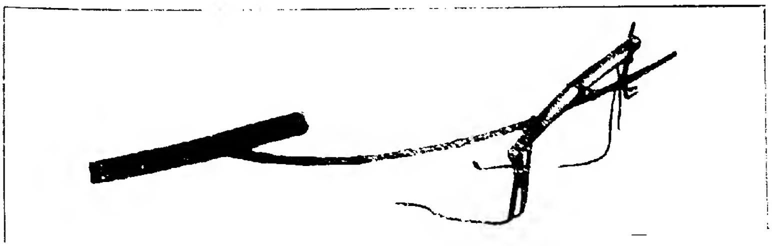
PLATE XXV.



From left to right. 1. [illegible] 2. Thumba large Hand-hoe. 3. Thumba small Hand-hoe.



Plough and Yoke.



means of a wooden peg, or it may be carved out of one block of wood; and invariably it carries a share at the end. It has nothing corresponding to the mould-board of English ploughs, and consequently it simply removes the soil on both sides without turning it over as the English plough does. The yoke is made of wood and resembles more or less the yoke in other parts of India. The *marram* (levelling rod) consists of a long but comparatively narrow rectangular block of wood, with its inside scooped out hollow. It is used for levelling the ploughed soil, breaking the clods, and sometimes for covering the seed. While in operation the driver stands on it so as to press it heavily on the ground. The spade consists of a wooden handle and an iron blade attached to it at right angles. The *thumba* (hand hoe) resembles the spade, the blade being, however, much smaller, and it is used chiefly for inter-culturing dibbled rice.

Systems of cultivation.—The conditions under which rice cultivation is carried on in Travancore are so varied in different parts of the State that it has not been possible to adopt a uniform system all over. There are in vogue at present several systems, the most important of which are briefly described below :—

In South Travancore rice is cultivated in low lands only, and two crops are ordinarily taken annually from the same land. The seed for the first crop is sown broadcast in April when the soil contains only just enough moisture to allow germination of the seed, and the crop is harvested in August. With the few showers that fall in March the land is prepared, and, if the season is favourable, sowing will be finished by the end of April. No water is let into the fields for about 30—40 days after sowing. The soil becomes quite dry by this time, and the young seedlings may turn yellow and appear to be almost dying. Then all of a sudden about the middle of June the monsoon bursts and brings with it torrential downpours. Water is then collected in the rice lands which are never again allowed to be completely drained. With the first fall of rain the seedlings assume their natural green colour and begin to grow with redoubled vigour. The changes that are seen in the seedlings in the course of a few

hours after the first shower may appear almost magical. It is common belief among the ryots that the yield will be considerably reduced if the lands are allowed to get wet during the drying period or to get dry after once the water has been let in. Both these conditions will favour the free growth of weeds which may probably be one of the causes of the reduction in yield.

In some rare years the rains in March and April may entirely fail, and in that case sowing will have to be postponed till the burst of the monsoon. Under such circumstances the method of cultivation described above becomes impracticable, and sowing in puddle is then adopted. The land for this purpose is ploughed and levelled under water, and the seed, which has been previously germinated, is broadcasted thereon. On the second or third day the water is drained off and the fields remain dry for about a week, after which water is let in again. This sowing is done in June and harvest takes place in October or August.

The second crop in South Travancore matures during the North-East Monsoon. The seed is sown in nursery beds in August, the seedlings are transplanted in September-October and the crops harvested in February.

In Central and North Travancore rice is cultivated on lands not on the hills. Low land rice fields are divided into three classes, viz. 1. *Veppu* 2. *Mundakan* and 3. *Puncha*.

Veppu fields occupy a higher level than the other two. They correspond more or less to the *Punja* lands in South Travancore, and like them carry two rice crops annually. The seed for the first crop is not germinated as in the South, but is dibbled in about the end of April. No water is allowed to collect in the fields till the seedlings have grown to a height of 4" or 5", and before water is let in the crop is intercultured with the *thoorpu* (hand-hoe) described above. Harvest in August takes place about the end of August or the beginning of September. Dibbling is no doubt more expensive than broadcasting, but it admits of easier and cheaper interculturing, hence is better suited to localities where there is a free growth of weeds. Immediately after the first crop is harvested the

fields are ploughed in water and puddled, and seedlings for the second crop, which have been previously grown in special nursery beds, are transplanted. This takes place about the middle of September and the crop is harvested about the middle of January. The fields at the time of harvest are fairly dry, and are at once ploughed or dug with a *thumba*, and a catch crop such as horse-gram or gingelly is sown immediately, which is harvested before the end of March, making room for starting operations for the succeeding rice crop. Thus it will be seen that *Veppu* lands are occupied by crops practically all through the year and do not get any rest whatsoever.

Mundaka.—Lands lie next to the *Veppu* and *Puja*, being higher than the latter and lower than the former. They are situated close to the backwaters and are subject to inundations, especially during the South-West Monsoon. They carry only one crop in the year which requires more than six months for maturing. The method of cultivation is the same as that of the second crop in *Veppu* lands. The seed is sown in nursery beds in June or July, the seedlings are planted in August or September, and the crop is harvested in January or February.

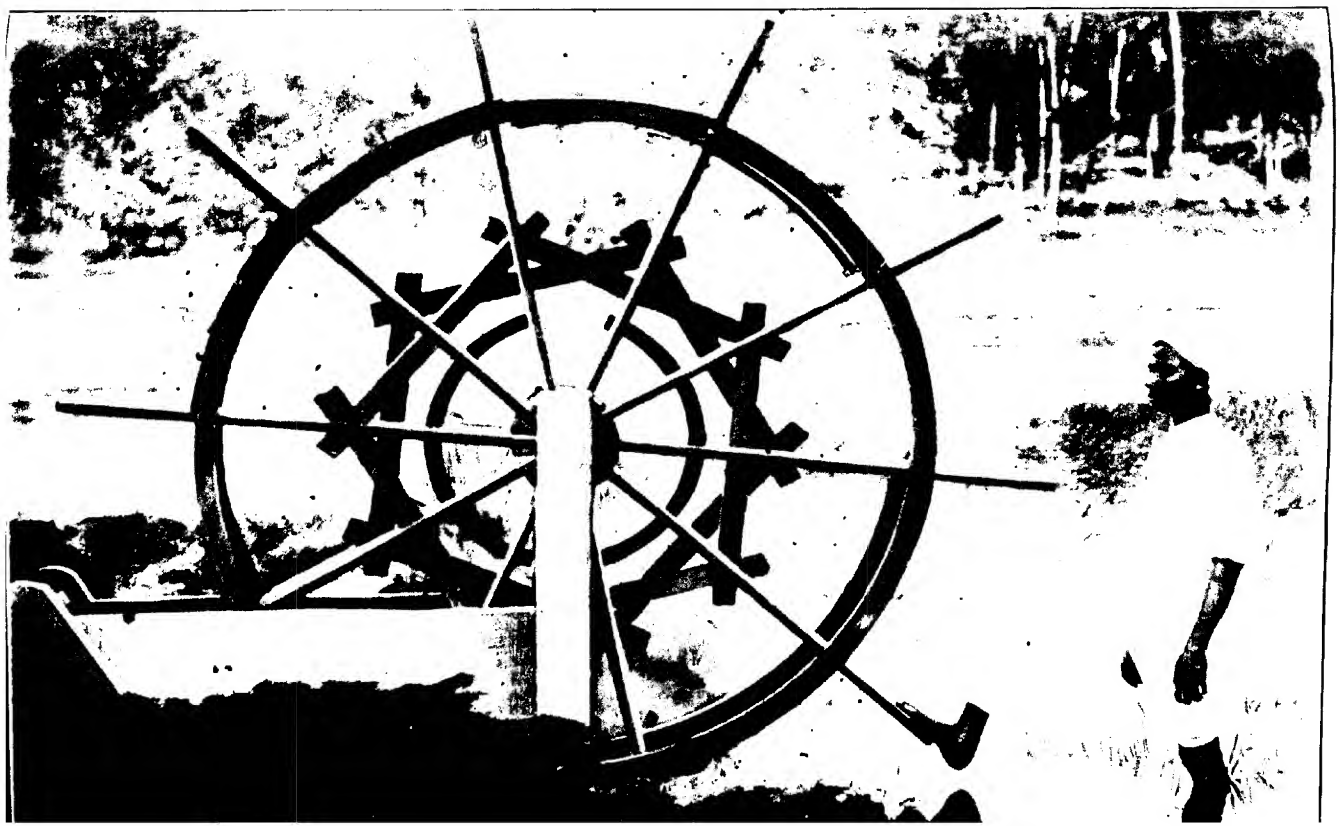
Puja lands are next to the *Mundaka* lands in the order of backwaters. They yield only one crop in the year, which occupies the ground from December to May, remaining fallow during the remaining part of the year they are completely under water. Cultivation starts with the removal of the rank vegetation and weeds with which the fields are overgrown during the rains. This operation is performed by scraping the bottom and sides of the fields when full of water, with a hand hoe. After this the soil is stirred by running the plough over it two or three times, with but one cattle being half immersed in water, as bullocks even swimming along during this operation. The next step is the construction of embankments which is well described by Messrs. Ward and Conner in their "Memoir of Travancore Survey," written in the early part of the nineteenth century as follows:—

"This is a tedious and difficult undertaking, commencing by fixing a double row of strong stakes measuring about twenty

feet firmly in the bottom, where they are two and three feet asunder but inclining inward: the breadth at the top diminishes to one-third of that distance, weeds and grass occupy the interstices in each row of poles, forming thus two slender divisions, the space between which is filled with mud taken from the channel along whose course they run. In this operation the Pulayan (the labourer) is frequently obliged to dive under water to some depth when having collected as much soil as can be secured with both hands on his head, he rises half enveloped in his miry load: if of shallow depth, the soil is taken with a large wooden hoe, the wall raised with such difficulty is elevated a few inches above the level of the water, as yet nearly in most places three feet deep, but which is now reduced to about as many inches by the *chakram* (water-wheel)."

From time immemorial the *chakram* has been the only instrument used in bailing water from *Punja* fields. It is rather a cumbrous machine and the method of its working is very laborious. About 24–30 men will have to work at it for two full days to bail three feet of water from one acre of land. In recent years some enterprising gentlemen have introduced engines and pumps for bailing water from *Punja* lands, and these are now gradually replacing the time-honoured *chakram*, especially among the rich ryots.

After the water has been bailed to a depth of three or four inches, the land is ploughed two or three times, and the seed, which has been previously germinated, is sown broadcast. On the third day the field is completely drained by means of the *chakram*, and is allowed to remain dry for about a week in order to quicken the growth of seedlings. On the tenth day water is bailed back into the field till the seedlings are about three-fourths immersed and is kept in that state for about a month, when it is again drained off and once more restored after a few days. These repeated inundations and drainage form a special feature of *Punja* cultivation. The crop matures in about four months and is usually harvested in March.



Hills and hill slopes that are used for rice cultivation are ordinarily known as *cherikals*. Cultivation of these lands begins with the clearing of the jungle and setting fire to it during the hot season, usually in February and March, the ashes derived therefrom being spread over the lands themselves. The soil is then slightly turned over, usually with the spade and very rarely with the plough, and the seed is broadcasted with the first rain in March. The varieties of rice used in *cherikal* cultivation are different from those used in low lands, and the seed rate in the former place is also considerably less than that in the latter. The *cherikal* rice crop requires full six months for maturing, the harvest usually taking place in August or September. Rice is invariably followed by a crop of horse-gram and in some places the latter is followed by cassava, after which the land lies fallow for from 6 to 10 years when cultivation is repeated again in the above order.

Manuring.—Systematic manuring of the rice crop is not common practice in Travancore except perhaps in the south. The ryots all over the State are utterly ignorant of the why and wherefore of the question of manuring. They have learned by the experience of centuries that manures will enhance the yield of crops, but they have yet to learn the scientific aspects of the question, a clear knowledge of which alone will enable them to improve their system of manuring.

The manures that are in common use for the rice crop are cattle dung, ashes, and green leaves. Cattle dung is a universal manure for all kinds of crops, but the quantity available is not at all adequate to the demand, and even the available quantity is not being properly collected and used. The defects in the collection and use of cattle dung are being constantly dinned into the ryots by the officers of the Agricultural Department, and as a result of this several of them have begun to improve their methods. Cattle dung is invariably applied to the first rice crop in South Travancore, while a mixture of cattle dung and ashes takes its place in Central and North Travancore. The ryots of

South Travancore spare no pains and grudge no expenditure in manuring their crops well. They collect all the dung available in their own farmsteads and get down a large quantity of it from the adjoining British territories at a cost of Rs. 2½ to 3 per cart-load. They usually apply 10 to 12 cart-loads of dung per acre. Their second crop is generally manured with green leaves, which they collect from their own gardens, and from the adjoining forests within and outside the State. They spend on an average Rs. 3 to 4 per cart-load of leaves, and about 5 or 6 cart-loads go into an acre. The leaves that are ordinarily used are those of *Thespesia populnea*, *Calotropis gigantea*, *Cassia fistula*, *Cassia auriculata*, and *Tephrosia purpurea* (Kolingi). The first three are trees and are grown in gardens, on the banks of canals and tanks, and in all other available grounds, while the last two are shrubs, and grow wild in gardens and forests.

In some parts of South Travancore a peculiar method of green-manuring is practised for the first rice crop. After water has been let into the fields for the first time, *i.e.*, when the seedlings are 5 to 6 inches high, they are lifted, with the surrounding soil, by the hand-hoe, and placed upon a layer of green leaves spread upon the ground. Within a week the seedlings develop fresh roots and begin to grow luxuriantly.

In Central and North Travancore green leaves are seldom used as manure probably owing to the great scarcity of trees and shrubs useful for the purpose. Green-manuring *in situ* by growing leguminous crops in rice lands and ploughing them in is not in vogue anywhere in Travancore, and it is doubtful whether the conditions under which rice cultivation is carried on here will admit of its introduction on a large scale.

The *Mundakan* and *Punja* lands in Central and North Travancore are seldom manured. Their fertility depends chiefly upon the silt that is brought down by floods during the rainy seasons. In places where there is not facility for a fair quantity of silt being deposited, the fields are cultivated in alternate years only.

In *cherikal* cultivation the only manure that is used is the ashes formed by burning the jungle. As these lands are allowed to lie fallow for from 6 to 10 years between the periods of cultivation, there is no necessity for the use of any special manure; but sooner or later this practice will have to be given up, and the question of an adequate supply of manures will then have to be considered.

The time is far distant when the Travancore ryot will be prepared to invest money in imported artificial manures. Partly owing to his ignorance of scientific agriculture and partly owing to his limited resources he is naturally averse to the use of such costly manures, and not only so, but he even allows some of the locally available manures to go out of the State instead of making use of them for enhancing the fertility of his lands. Under this category come oil-cakes, fish refuse, and bones, all of which are now mostly exported to foreign countries for manurial purposes. The State Agricultural Department is trying to impress upon the ryots the high manurial value of these stuffs, and I am glad to say that its labours have not been altogether unfruitful.

Harvest and preparation of the grain.—Rice is cut by the sickle and tied into small sheaves. If the stalks are good, they are cut close to the ground, so that the straw may be used as fodder for cattle, and if not, the ears alone are taken. In some places the sheaves are tied into bundles and carried to the farmstead for threshing, while in other places threshing is done in a corner of the field itself.

The following two methods of threshing are common in Travancore: (1) A man takes the sheaves one by one and strikes them on the ground two or three times. By this operation more than 95 of the grain will be separated from the stalks. The sheaves are then stacked for a few days, after which they are taken out, spread on the ground, and threshed completely by being trodden on by cattle or by being beaten with long sticks by women. (2) The second method of threshing is treading by men. A long beam is placed on two pillars fixed in the ground.

The men, standing on the sheaves which are placed on the ground, take hold of the beam with both the hands and rub the earheads between their feet as hard as they can. This process, though laborious, is very efficient, inasmuch as not a single grain will be left on the stalks after the operation. The threshed grain is dried in the sun for two or three days; after it is well dried, the chaff is separated from the grain with the help of the wind, and the produce is then ready for the market. The use of reaping, threshing, and winnowing machines is as yet unknown in Travancore. As the rice lands are divided into small compartments and as the soil is generally in a miry condition at the time of harvest, the introduction of reaping machines is quite out of the question: but as regards the other two machines there is full facility for their introduction, and the ryots are, therefore, being gradually educatep in the uses and advantages of these.

NOTES.

Sorghum Poisoning.—Investigations in respect of the poisonous properties of sorghum have been made in many of the dairying countries of the world. In Queensland, some years ago, a number of dairy cattle suddenly died while feeding on sorghum. At first hoven, or bloat, was suspected as the cause of death; but, owing to the rapidity with which the cattle succumbed, more virulent causes than those arising from the mere gorging of the animals were looked for.

Cause of Poison in Sorghum. The number of deaths among the dairy cattle in Queensland, in the year 1903, led the Department of Agriculture in that State to a strict investigation concerning sorghum, with a view to determining whether the mortality among the cows was due to any poisonous constituents the plant contained.

It was shown that in some cases fields of sorghum, with only a dividing fence between, gave entirely different feeding results, although the sorghum from each field was fed to the cattle at similar stages of its growth. One herd would be affected on one side of the fence, while the herd on the other side, in a field immediately adjacent, thrived on the succulent fodder. In each field the cows were grazing on young sorghum.

Dr. Maxwell and Mr. J. C. Brunnich, Chemists of the Queensland Department, undertook to solve the problem, which seemed at the time to have certain elements of mystery. It was naturally a puzzling situation to dairy farmers. Without definite proof they could not be convinced that the sorghum was responsible for the deaths of their cattle.

It has been known to science for some years that sorghum and similar plants, grown in rich soils, were more liable to

contain highly dangerous amounts of hydrocyanic acid—commonly known as prussic acid—than when grown in soils poor in nitrogen. It was found that the nature of different soils very largely governed the amount of these poisonous properties in the plant. This explained why some cows were affected through eating sorghum in one field, while those in an adjoining field consuming the same class of material, did well. The changing character of the soil varied the amounts of prussic acid.

In a specific case it was noticed that one field—in which cattle were immune—gradually sloped upwards. The analysis of the soil from this field showed a deficiency in nitrogen.

Testing Sorghum Growths for Poison.—To test the relation between the incorporation of the prussic acid in the growing sorghum plant, and the ratio of the nitrogen in the soil, several plantings of sorghum were made in the Botanic Gardens at Brisbane, in soil composed almost exclusively of sand. One series of plants was not given any special manurial assistance, while another series was manured with nitrate of soda, a manure whose chief element is nitrogen. This experiment was made in order to see whether the supply of additional nitrogen to the soil would increase the amount of prussic acid in the growing plant—nitrogen being an element of that poison.

Mr. Brunnich made repeated analyses which showed, with almost mathematical precision, that the supply of available nitrogen increases the amount of poison that sorghum and other plants are capable of making and storing up within their composition.

Sorghum Poison at Different Stages of Growth.—Determining the stages in the growth of sorghum when the poison in it would be at the danger limit, was a very interesting and valuable phase of the investigation. It was found by the experiments that sorghum grown in highly rich, nitrogenous soils could not be freely fed to animals with safety until the plant is preparing to seed.

The sorghum plant—grown under the conditions described—when very young, and from the age of 3 up to 7 weeks, con-tains

distinctly dangerous amounts of prussic acid. After that age the poison rapidly disappears by decomposition, the nitrogen passing over into other and strictly nutritious elements of food. When the flowering stage is reached, not more than a trace of the poison is found.

As the growth of the plant does not entirely depend upon the age or the number of weeks since it was planted, it is as well to speak of its stages of development. It may be generally stated that the sorghum plant is not safe for feeding until it reaches the flowering or seeding stage.

When Young Sorghum is Mixed it is not dangerous.—Dr. Maxwell reported that even sorghum, and such plants as may be known to contain dangerous amounts of prussic acid, may be judiciously used as a green mixture with dry hay chaff to make the feed tasty to animals. When diluted in this way, the green sorghum being very carefully stirred up and mixed with large quantities of the dry feed, no harm will follow. The dry feed is, in this way, also made capable of use.

That there is a danger in allowing stock free course to the young growing sorghum is beyond doubt, since it has been proven that the whole trouble is due to the presence of the poison as stated. The fact of the poison being prussic acid accounts for the sudden fatalities immediately following when cows have free access to sorghum produced under the conditions outlined. The prussic acid rapidly spreads through the system, and has an almost immediate fatal effect.

It may be mentioned that these plant-poison investigations have been extended to include maize, sugarcane, and most of the grasses in use. Prussic acid has been found in quantities varying from *nil* a mere trace and up to the danger point. So far, however, only *Panicum sativum* comes anywhere near the sorghum plant in its dangerous content of the poison. Sugarcane and *Paspalum dilatatum* were found free of prussic acid. Traces were found in maize produced in rich soil, but not near the danger limit. (*Agricultural Gazette of New South Wales*, November 1911.)

(1). MAIZE AS A SUGAR CROP.—(Le Maïs, culture sucrière.) *Bulletin agricole de l'Algérie et de la Tunisie*, 17e. An., No. 11, pp. 303-304. Alger, 1er Juin, 1911.

So far sugar manufacturers have never thought of utilising the proportion of sugar which maize, like sorghum and sugar cane, contains in its stalk[1].

If the ear is detached from the stalk when still milky, a gradual but constant accumulation of sugar takes place in the stalk, equal to the average sugar content of the best sugarcane (17 per cent.)

Moreover, maize from which the ear has been removed, no longer assimilates the silica which encrusts the peripheric fibres of the stalk, thus making it impossible to utilise the pulp. When the sugar has been drawn off, the whole substance of the stalk could be reduced to pulp and cellulose for paper-mills, or could be made into denatured alcohol, or pressed to form a cattle-feed.

According to Prof. Stewart, maize contains 88 per cent. of sap with 13 per cent. of sugar, which means a yield of from 81 to 91 kgs. of sugar and 90 kgs. of pulp per tonne[2]. The green ears would yield 10 per cent. of their weight in alcohol at 95° and a residuum of 5 per cent. in pulp and oil-cake, rich in albuminous matter.

A company with a capital of 10 million dollars has set up a factory at Murrysville, Westmoreland Co., Pa., which is now at work drawing off the sugar from maize and using its other industrial bye-products.

(2). TREATMENT OF FOOT-AND-MOUTH DISEASE.—(Ein brauchbares Mittel bei Behandlung der Maul-und Klauenseuche.) *Zeitschrift der Landwirtschafts-kammer für das Herzogt.*

[1] "Cortez informed Charles V that bees' honey, wax and maize stalk honey was sold the market at Tlatloc. Maraiell was the first European to obtain a syrup, similar to that from maize stalks; this syrup is afterwards converted into solid sugar, similar to cane-sugar. Messrs. Barger, Parmentier, Deyeux, Tietot and many other chemists have since obtained sugar from maize-stalks, either green or dried." Carlo Perin-Pich. *Instituzioni di Agricoltura*. Torino. 1863, Vol. IV, p. 1121.

[2] 1 tonne = 1,000 kgs. = 0·984 ton (English).

Braunschweig, 80 J. Nr. 16, S. 202. Braunschweig, 21 Juli, 1911.

Treatment with nitric acid for foot-and-mouth disease is here described. For cows two or three tablespoonfuls a day of nitric acid at 15 grs. per litre of water (2½ ozs. in 1 gallon) is said to prevent infection and effect a cure within a week: the hoofs should also be washed, and painted with wood-tar: and the udders should be washed with nitric acid at one-third of the above strength before and after milking.

Pigs and calves should have only one to two tablespoonfuls a day.

(Bulletin of the Bureau of Agricultural Intelligence and of Plant Diseases. International Institute of Agriculture. Rome, July 1911.)

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Soy Beans.—The Report on the Agricultural Stations in the Central Provinces and Berar for the year 1910-11 contains a few notes on the experiments with the cultivation of Soy Bean at the Powarkhera and Nagpur College farms. At the former station "a small seeded Japanese variety, which had been acclimatized at Nagpur, was grown on about ¼ acre of *aorund* soil. The crop is very hardy and grew splendidly, giving a yield of above 800 lbs. beans per acre. The seed was analysed by the Agricultural Chemist and gave a very disappointing oil percentage, *viz.*, 10 per cent. This variety is evidently more suited for forage purposes, and some new varieties, which have been obtained from Manchuria this year by the courtesy of Messrs. Ralli Brothers, will be tried this year." On the Nagpur College Farm "the farm variety, introduced in 1882, was grown on an extended scale this year with and without superphosphate: 10 acres were sown. The land chosen was a field which previously had grown wheat or gram, a low-lying heavy *cabi* field. The outturn was 660 lbs. per acre over the whole area. This is a small-seeded late variety. The percentage of oil is only 13, too low for commercial purposes. It contains a high percentage of proteid and should be a good stock feed. It may be regarded as a fodder

variety. Some 15 new varieties were tried this year, and it is hoped a number of new imported ones will be available for trial in 1911-12. Some of the varieties tried, look as if they might be promising." At Pusa too, soy beans obtained from Nagpur were tried, with the result that a yield of nearly seven maunds per acre was obtained, which is not sufficient to pay for the cultivation and for the occupation of the land for two seasons.—[EDITOR.

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A BRIEF NOTE ON THE *Kans* WEED (*Saccharum spontaneum*).—The *kans* is a noxious aggressive jungle grass and a great enemy to cultivation. It is the principal obstacle in the cultivation of the Malwa Plateau of Central India and some of the Bundelkhand tracts of the United Provinces. Some say that it is due to age of cultivation, that is, when cultivation is carried on continuously for a long period, the soil gets exhausted and worn out and the *kans* breaks up: others hold that it is due to land lying fallow for a considerable period; while others again consider that it is due to the want of intensiveness in cultivation in sparsely populated tracts. Its causes are thus as yet undefinable. It is certainly indicative of good soil. In the Malwa Plateau its roots are very deep, ranging between 6 and 8 feet. It abounds chiefly in *jhar* fields which seem to favour its growth. It causes a serious depression in agriculture and a loss of revenue to the State. Various methods have been suggested to eradicate it, such as a special plough or the swamping of the infected area and so forth, but I am not in a position to say how far these methods have proved successful. Tenants are not able to suggest any remedy in eradicating it, but experience gained in Malwa shows that it is only by the continuous growing of *rabi* crops it is kept in check. Wheat alternated by gram does a good deal in causing it to disappear. If this operation fails, the land must lie fallow for a period of 10 to 25 years when *kans* dies a natural death. In cases where irrigation is possible, some better results might be achieved but the labour and outlay are considerable.

As regards the effect of *kans* on revenue, the method adopted by the Hon'ble Mr. H. J. Hoare, I.C.S., late Settlement Commis-

sioner of Indore, reduces to an appreciable extent the hardships of the tenants. He introduced a factor known as "Kansla" into the assessment of the *kans* tract by deducting 12½% off the rental from the gross assessments. And the subsequent rules were that if a tenant did not cultivate a *kans* field, two-thirds of the assessment would be let off in that year. But if he brings that field under cultivation again, the full assessment as originally imposed at settlement will be recovered in that year. This has led to a distinct gain both for the tenant and the proprietor.

If the treatment of *kans* land is viewed in this way in *kans*-infested districts, it will only be in extreme cases that a necessity on the part of a tenant will arise to abandon his *kans*-infested holding. (AJUDHYA PRASAD.)

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SALTS FOR PADDY.—Those who have grown paddy under careful observation and on their own responsibility without local expert assistance, will probably have noticed its extraordinary vagaries under different treatments. Though paddy is no doubt an exceedingly easy crop to grow if certain simple rules are observed, neglect of these essentials appears to be absolutely fatal to the production of a full crop. An instance to the point is the well-known fact that in certain soils early ploughing after harvest diminishes the yield of the following paddy crop. Another is the practice called *nigar* in Shahabad—the draining of paddy-fields in the last fortnight of September and re-flooding early in October—which is the despair of the Canal Department, but has been found to give an average increase of paddy of nearly 8 maunds per acre at Dumraon, over 3 years.

From time to time curious practices in paddy cultivation come to light. One is that mentioned by Graham (*Agricultural Journal of India*, Vol. VI, Part IV) of throwing the leaves of a poisonous plant (*Christanthus collinus*) on the water of paddy-fields attacked by stem-borer. Another, to which Dr. Leather has drawn my attention, is the use of the leaves of *basúti* (*Adhatoda vasica*) by cultivators in the Sutlej Valley before planting paddy, for the alleged purpose of killing aquatic weeds that would other-

wise injure the rice crop. An infusion of these leaves has been shown to be poisonous to aquatic life generally. (Handbook of Commercial Products No. 10. *Adhatoda vasica.*)

Khari Nimak (Crude Sulphate of Soda) is used by cultivators in small quantities—a few pounds per acre—to cure a disease of paddy, in Shahabad, said to be due to south winds.

In 1910 sulphate of magnesia was applied by Smith, in October, at Cuttack in Orissa, and at Bankipur in Bihar (see the reports of the Bengal Agricultural Department, for 1910-11) It produced no appreciable effect at Cuttack where the soil is sandy, but at Bankipur on heavy soil, already rich in magnesia, one maund of the salt apparently gave an increased yield of $7\frac{1}{2}$ maunds of paddy : 2 maunds of salt, 14 maunds of paddy; and 3 maunds, 13 maunds of paddy, per acre, more than the untreated plot. Owing to this somewhat surprising result, a rough experiment was tried at Pusa in 1911, one maund per acre of *Khari Nimak* being applied to $2\frac{1}{2}$ acres of paddy, and an adjoining similar area being left untreated. The treated land gave over 38 maunds, the untreated, 21 maunds per acre. The previous fertility of these plots had not been compared, and the experiment was not in any way exact, but the difference in yield is very great and possibly significant. Considered in conjunction with the uses of poisonous leaves referred to above and with the practice of *nigar* in Shahabad, these apparently striking effects of the application of these salts so late as October, just before the paddy flowers, may indicate the presence in the water of paddy-fields under certain conditions, of some deleterious factor, possibly biological or of biological origin, which can be rendered inactive in various ways.

The point would seem to be one that would well repay investigation both in the laboratory and in the field. (A. C. Dobbs.)

Field Rat Extermination.—Landowners troubled with rats or mice might try a method of destruction which has been followed with success in Faridkot. An ordinary brazier (angithi) is provided with a dome-shaped cover, in the centre of which is a small funnel. To the funnel is attached a piece of flexible

tubing and to that again an iron pipe. Sulphur is sprinkled on live charcoal in the brazier and the fumes are carried by the pipe into the mouse-hole. They ramify through the holes and kill the inmates. Neighbouring exit holes should be blocked up as far as possible. (From the *Punjab Agricultural Notes.*)

REVIEWS.

PRELIMINARY STUDY OF THE RED ROT OF SUGARCANE IN THE BOMBAY PRESIDENCY, BY G. S. KULKARNI, L.AG., ASSISTANT MYCOLOGIST, DEPARTMENT OF AGRICULTURE, BOMBAY, BULLETIN NO. 44. PRICE AS. 8 OR 9*d*.

MR. KULKARNI toured in the chief sugarcane-growing districts of the Bombay Presidency in order to study the distribution of the disease "Red Rot" which causes so much loss to growers of cane. The disease was found to be common on thick canes, especially on canal-irrigated areas, and where careful selection of sets is not practised, it has become epidemic. When red rot is present, although canes may look healthy, there is a great reduction of sugar, because the effect of the fungus on the cane is the inversion of sucrose. As regards checking the disease, Mr. Kulkarni says:—"From the experience so far gained it is evident that *infection occurs mostly through the diseased 'sets' being planted.* It is, therefore, clear that if selection of sound cuttings for planting is carried out consistently and steadily, there will be little danger of a general outbreak of disease. There is probably no part in the whole operation of the cultivation of sugarcane, where a little time can be so profitably spent as in the inspection of cuttings to be employed for seed. Almost every cane field contains some plants attacked by red

rot. It is perhaps not possible, as yet, absolutely to prevent its appearance ; but it can be checked and prevented from being an epidemic. *Of all the precautions which can be taken to check cane diseases the most important is selection and examination of 'sets' for planting.* It should be as essential a part of the routine practice in planting as the preparation of soil, manuring, etc. The healthiest portion of the field should be carefully inspected previous to harvesting, care being taken to remove all patches which are stunted, or poorer in any way than the surrounding crop. *Then the sets from these canes should be carefully examined. Only those that have white pith at the cut ends should be selected, and all those that show any sign of reddening should be unhesitatingly condemned.* There is no doubt that this rule will in many cases act so as to exclude the greater number of the cuttings, and in places, like Sholapur, where top sets only are planted, there will be very few sets left for planting big areas But even if this is the case, the inclusion of any such canes in the seed is fraught with the danger of propagating the disease. These very few sets should be planted separately, in a well-drained part of the field, and next year again selection should be made, and in two or three years there will be a sufficient number of good cuttings to plant the whole estate.

"The other mode of treatment is the selection of varieties. In some cases most careful selection of sets will fail to reduce the disease within manageable limits. In such cases the efficacious remedy is to replace the affected variety by others which are more resistant to the disease.

"Which line of treatment should be adopted first will depend upon the value of the variety attacked. If it should be a valuable variety, greatly superior to any that are known to be resistant, it would be better to attempt to eradicate the disease by careful selection and possibly by importing clean 'sets' from another locality."

Planters of sugarcane will probably find these recommendations well worth their attention.—(A. C. D.)

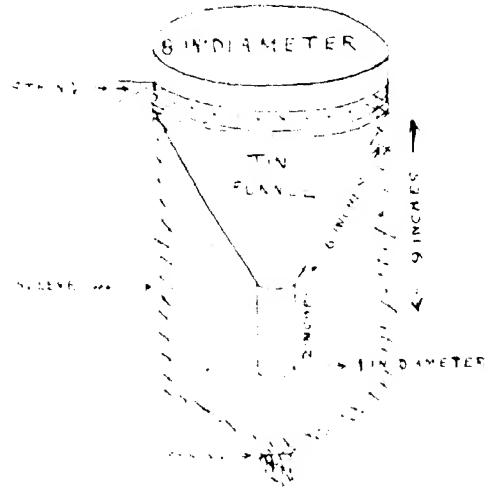
THE IMPROVEMENT IN THE YIELD AND QUALITY OF INDIAN WHEAT, BY ALBERT HOWARD, M.A., A.R.C.S., F.L.S., IMPERIAL ECONOMIC BOTANIST, AND GABRIELLE L. C. HOWARD, M.A., ASSOCIATE AND SOME TIME FELLOW OF NEWNHAM COLLEGE, PERSONAL ASSISTANT TO THE IMPERIAL ECONOMIC BOTANIST (Reprint from the Journal of the Bombay Natural History Society, October 31, 1911.)

IN this paper, read before the Bombay Natural History Society, Mr. and Mrs. Howard give a sketch of the wheat investigations which have formed so large a part of their work at Pusa since 1906. The survey, selection and hybridization work which has resulted in the production of pure types of wheat some of which have been pronounced by expert opinion, after thorough milling and baking tests, to be equal in value to the best Manitoba wheat, is described, and the authors go on to refer to the system on which the land on which these wheats are grown is treated, which, the authors say, is "merely the application of commonsense to crop production in the plains." A great deal has been heard of dry-farming methods and there has been much speculation as to the causes of the well-known beneficial results of the continued cultivation of the soil and its exposure to the sun in the hot weather, but it is only the explanations put forward that are new, and they may or may not be correct. The principles themselves have probably been established among agriculturists since the dawn of agriculture. It is characteristic of the authors of this paper that they should have carried the logical and consistent application of these principles through till they produced the results described, but when they refer to the "conversion of the Agricultural Department," they appear to lose sight of the fact that it is just in the application and not in the perception of such principles that the difficulty lies. The efforts of the Agriculturists in the Provincial Departments of Northern India have for long been devoted to the devising of means for economising human labour and cattle power at harvest time, so that the stubbles can be ploughed as early as possible

and with the gradual improvement effected by the introduction of reapers, winnowers, and perhaps threshing machines and specially designed ploughs, the wholesale application of the principles referred to will no doubt soon become possible. From this point of view the "conversion of the Agricultural Department" appears to depend on the recruiting of engineering skill rather than on the inculcation of accepted principles.—(A. C. D.)

THE COTTON STAINER BUG, BY P. L. GUPPY AND T. THORNTON (BOARD OF AGRICULTURE, TRINIDAD: CIRCULAR No. 6, 1911.) PAGES 23, ONE PLATE AND 12 TEXT-FIGURES.

As its title implies, this Bulletin deals with the West Indian Cotton Stainer Bug (*Dysdercus howardi*) which is stated to be the worst pest of cotton in Trinidad and Tobago. In its general appearance and habits this insect approximates closely to the Indian Red Cotton-Bug (*D. cingulatus*) whose life-history



has been detailed in Entomological Memoir No. 3 of Volume II. The methods found of use for the control of this bug in the West Indies are therefore of interest to us in the East. Those

found most successful are (i) trapping of the bugs by means of balls of seed cotton tied up into bundles about the size of a fist and suspended on the topmost branches resting against the main stem, and (ii) collecting the bugs whilst the cotton is being picked. For this purpose use is made of a tin funnel with an attached sleeve or bag of cloth, the bugs being shaken into the funnel and falling down into the bag, where they are collected until the bag is full or nearly so, when the string at the lower end of the bag is untied and the bugs emptied into a vessel containing water with a film of oil on top. The figure on page 215 will explain itself. The funnel bag can of course be used also to collect the bugs which have been attracted by the seed cotton traps. [T. B. F.]

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DAMAGE BY BEETLES IN TEA-CHEST WOODS, BY G. D. HOPE AND C. B. ANTRAM. CALCUTTA: INDIAN TEA ASSOCIATION, 1912. 13 PAGES AND ONE TEXT FIGURE. PRICE 6 ANNAS.

THIS Bulletin deals briefly with the different kinds of insects which attack, or are found in, the various varieties of woods used in the manufacture of tea-chests, the periods at which attack takes place, the extent to which the different kinds of woods used for tea-chests are susceptible to attack, and the effect of seasoning of wood on its susceptibility to attack.

This inquiry was commenced as a result of the discovery that tea-chests, in which tea had been sent from Calcutta to Australia, were found on arrival to have been attacked by boring beetles which were living in the wood. The Australian authorities objected to the immigration of such undesirable aliens and pointed out that the importers were liable to a fine of ten pounds for every specimen of a noxious insect thus brought into the country. It therefore became a matter of considerable pecuniary interest to the shippers to find out how the chests became infected and how to prevent the damage. The present paper is a short preliminary résumé of the investigations made into this

ubject by the Scientific Department of the Indian Tea Association. A long list is given of the various insects found in ea-chest woods, many of them mere casual visitors, the worst ests being beetles of the family of "Shot-hole Borers." The ood is most frequently attacked where stored and left undisturbed in godowns, etc., in contact with sawdust and woodfuse. Soft woods, such as *Simal* (Bombax malabaricum), re attacked to a greater extent than hard ones, and unseasoned ood is attacked more readily than seasoned.—(T. B. F.)

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REEN-MANURING IN MYSORE. BY LESLIE C. COLEMAN, M.A., PH.D., AND OTHERS. BULLETIN No. 1 OF THE GENERAL SERIES ISSUED BY THE DEPARTMENT OF AGRICULTURE, MYSORE STATE. 8 PLATES & 3 TEXT FIGURES. PRICE 8 annas.

THE practice of green-manuring is receiving the attention deserves on the part of the State all over India. In the unjab, water rates are remitted on crops of sannai (*Crotalaria juncea*) sown for green manuring under certain conditions, and Madras, the Department of Agriculture has undertaken the upply of seed of Sesbania for this purpose. This bulletin on reen-manuring in Mysore not only explains what is already the ractice in that State and how this practice may be improved, ut gives a very clear and concise account of the way in which guminous crops benefit the soil when ploughed in. A series f excellent photographs help to bring home to all who can ppreciate such aids, the definite nature of our knowledge of he peculiar function of leguminous crops as nitrogen gatherers, nd, with the analyses given, make this bulletin of interest to griculturists in other parts of India.

The case for green manuring in general is perhaps underather than overstated, no mention being made of the probability hat a considerable further addition is made to the nitrogen in he soil by the action of bacteria, other than those found in the oot nodules, on the rotting carbonaceous material ploughed in. On the other hand, we are not sure that everyone will agree with

the authors of the bulletin in condemning the cultivators of Mysore for yielding to the temptation to gather what crop they can before ploughing the remainder in. The primary object of agriculture is to get a crop : the principle of a bird in the hand being worth two in the bush carries greater weight in a country where rates of interest are high and crop conditions more or less precarious, and the question of how much of a crop it pays to gather and how much to plough in will probably always depend more on whether the crop is worth gathering than on any considerations as to its value for ploughing in as a manure. The essential principle of green-manuring appears to be to keep crops on the ground whenever possible, ploughing them in when there is no better way of disposing of them. Perhaps, the most promising extension of the application of the principle in India is the system referred to in this bulletin, of broadcasting the green manure seed in paddy, a week or two before the crop is cut. - (A. C. D.)

LIST OF AGRICULTURAL PUBLICATIONS IN INDIA FROM THE 1st AUGUST 1911 TO 31st JANUARY 1912

	Author.	Where published.
	General Agriculture.	
The *Agricultural Journal of India*, Vol. VI, Part IV and Vol. VII, Part I. Price per part, Re. 2. Annual subscription Rs. 6.	Agricultural Research Institute and College, Pusa, Bihar	Messrs. Thacker, Spink & Co., Calcutta
Proceedings of the Seventh Meeting of the Board of Agriculture in India, held at Pusa on 29th November 1911 and following days, with Appendices. Price 8 annas.	Inspector General of Agriculture in India	Government Printing, India, Calcutta.
Report of the Agricultural Research Institute and College, Pusa (including the Report of the Imperial Cotton Specialist) for 1910-11. Price 6 annas or 7d.	Director, Agricultural Research Institute, Pusa	Ditto
Report on the Progress of Agriculture in India for 1910-11. Price 12 annas or 1s. 3d.	Inspector General of Agriculture in India	Ditto
Agricultural Statistics of India for the years 1906-07 to 1909-10. Price Rs. 2-8.	Director General of Commercial Intelligence	Government Press, India, Calcutta.
Agricultural Ledger, 1911 No. 1. Vegetable Products Series No. 115. Cinchona bark. Price 9 Annas.	Reports on Economic Products to the Government of India	Government Printing, India, Calcutta.
Quarterly Journal, Vol. V, Nos. I-A 2 for July and October 1911. Price 6 annas per Part.	Department of Agriculture, Bengal	Bengal Secretariat Press, Calcutta.
Annual Report of the Department of Agriculture, Bengal, for the year ending 30th June 1911. Price 7 annas.	Ditto.	Ditto.
Annual Report of the Kalimpong Demonstration Farm, for the year 1910-11. Price 4 annas.	F. W. Goodenough	Ditto.
Annual Report of the Bankipur Agricultural Station, for the year 1910-11. Price 2 annas.	A. C. Dobbs, B.A.	Ditto.
Annual Report of the Dumraon Agricultural Station, for the year 1910-11. Price 1 anna.	Ditto	Ditto.
Annual Report of the Chinsurah Agricultural Station, for 1910-11. Price 6 annas.	Ditto	Ditto.
Note on the Work of the Burdwan Agricultural Station, for 1910-11. Price 1 anna.	Ditto	Ditto.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title.	Author.	Where published.
	General Agriculture—contd.		
14	Agricultural Statistics of Bengal, for 1910-11. Price Re. 1-4.	Department of Agriculture, Bengal.	Bengal Secretariat Press, Calcutta.
15	Principles of Agriculture for Bengal. Price Rs. 3.	F. Smith, B. Sc., F.H.A.S., Deputy Director of Agriculture, Bengal.	Bengal Secretariat Book Depôt, Calcutta
16	Annual Report on the Administration of the Department of Agriculture, United Provinces, for the year ending 30th June 1911. Price 8 annas or 9*d.*	W. H. Moreland, C.I.E., I.C.S., Director of Land Records and Agriculture, United Provinces.	Government Press, United Provinces, Allahabad.
17	Annual Report of the Cawnpur Agricultural Station, for the years 1909-10 and 1910-11. Price Re. 1 or 1*s.* 6*d.*	Ditto.	Ditto.
18	Annual Report of the Orai (Jalaun) Agricultural Station, for the years 1909-10 and 1910-11. Price 8 annas or 9*d.*	Ditto.	Ditto.
19	Annual Report of the Aligarh Agricultural Station, for the year 1910-11. Price 8 annas or 9*d.*	Ditto.	Ditto
20	Bulletin No 26. Description of the working Sugar Factory exhibited in the Agricultural Court, U. P. Exhibition, by Messrs. Blair Campbell & McLean. (Price not given).	B. C. Burt, B.Sc. (London), I.C.S., Deputy Director of Agriculture, Central Circle, Cawnpur, U. P.	Ditto.
21	Urdu Translation of the Proceedings of the Agricultural Conference held at the U. P. Exhibition, Allahabad, in January 1911.	Department of Agriculture, U. P.	Newal Kishore Press, Lucknow.
22	Season and Crop Report of the United Provinces for 1910-11. Price 8 annas or 9*d.*	Ditto	Government Press, United Provinces, Allahabad.
23	Report of the Government Horticultural Gardens, Lucknow, 1910-11. Price 3 annas or 3*d.*	Ditto.	Ditto.
24	Breeds of Indian Cattle, U. P.	Ditto.	Superintendent, Government Press, Allahabad.
25	Report on the Operations of the Department of Agriculture, Punjab, for 1910-11. Price 7 annas or 7*d.*	W. S. Hamilton, I.C.S., Director of Agriculture and Industries, Punjab.	Punjab Government Press Lahore.
26	Report on the Season and Crops of the Punjab, for the year 1910-11. Price 9 annas.	Ditto.	Ditto
27	Annual Report of the Department of Agriculture, Bombay, for 1910-11. Price 12 annas or 1*s.* 2*d.*	G. F. Keatinge, I.C.S., Director of Agriculture, Bombay Presidency.	Government Central Press, Bombay.
28	Season and Crop Report of the Bombay Presidency for 1910-11. Price 7 annas or 8*d.*	Ditto.	Ditto.
29	Annual Report on the experimental work of the Surat Farm, for 1910-11. Price Re. 1.	T. F. Main, B.Sc., Deputy Director of Agriculture, Bombay Presidency.	Ditto.
30	Annual Report on the experimental work of the Dharwar Farm, for 1910-11. Price Re. 1.	Ditto.	Ditto.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

	Title.	Author.	Where published.
	General Agriculture—contd.		
31	Annual Report on the experimental work of the Dhulia Farm, for 1910-11. Price 14 annas or 1*s.* 4*d.*	T. F. Main, B.Sc., Deputy Director of Agriculture, Bombay Presidency.	Government Central Press, Bombay.
32	Annual Report on the experimental work of the Nadiad Farm, for 1910-11. Price 12 annas or 1*s.* 2*d.*	Ditto.	Ditto.
33	Annual Report on the experimental work of the Dohad Farm, for 1910-11. Price 12 annas or 1*s.* 2*d.*	Ditto.	Ditto.
34	Annual Report on the experimental work of the Gokak Farm, for 1910-11. Price 12 annas or 1*s.* 2*d.*	Ditto.	Ditto.
35	Annual Report on the experimental work of the Mirpurkhas Farm, for the year 1910-11. Price 5 annas or 6 pence.	G. S. Henderson, N.D.A., N.D.D., Deputy Director of Agriculture.	Ditto.
36	Annual Report on the experimental work of the Manjri Farm, for 1910-11. Price 4 annas or 5 pence.	J. B. Knight, M.Sc., Professor of Agriculture	Ditto.
37	Annual Report on the experimental work of the Lonavla Farm, for 1910-11. Price 4 annas or 5 pence.	Ditto.	Ditto.
38	Annual Report of the Kirkee Civil Dairy Farm, for 1910-11. Price 4 annas or 5 pence.	Ditto.	Ditto.
39	Annual Report on the Agricultural College Station, Poona, for 1910-11. Price 5 annas or 6 pence.	Ditto.	Ditto.
40	Annual Report on the experimental work of the Ganeshkhind Gardens. Price 4 annas or 5 pence.	W. Burns, D.Sc., Economic Botanist, Bombay Presidency.	Ditto.
41	Annual Report on the Rassein Gardens. Price 4 annas or 5 pence.	Ditto.	Ditto.
42	*San* Hemp. Bulletin No. 47. Price 4 annas or 5 pence.	P. C. Patil, L.Ag., Divisional Inspector of Agriculture, Central Division, Bombay.	Ditto.
43	Poona Furnace. Bulletin No. 48. Price 7 annas or 9 pence.	Ditto.	Ditto.
44	An Examination of the seed Supply of the Ahmednagar District. Part I. Price 5 annas or 6 pence.	G. D. Mehta, L.Ag., B.A., N.D.A., N.D.D. Supernumerary Agriculturist, working at Poona.	Ditto.
45	Annual Report of the Empress and the Rund Gardens, Poona, for 1910-11.	.....	Arya Bhusan Press, Poona.
46	Broach Cotton. Seed Selection Series. Bulletin No. 46. Price 8 annas	T. F. Main, B.Sc., Deputy Director of Agriculture, Bombay Presidency.	Government Central Press, Bombay.
47	Report on the Operations of the Department of Agriculture, Madras Presidency, for 1910-11. Price 3 annas or 3 pence.	M. E. Couchman, I.C.S., Director of Agriculture, Madras.	Government Press, Madras.
48	Season and Crop Report of the Madras Presidency, for 1910-11. Price 4 annas or 6 pence.	Ditto.	Ditto.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title.	Author.	Where Published.
	General Agriculture—contd.		
49	Hindupur Agave Plantation. Bulletin No. 61. Price 3 pies	G. R. Hilson, B.sc., Deputy Director of Agriculture, Madras.	Government Press, Madras
50	The Importance of Sowing Pure Seed of Cambodia Cotton. Leaflet No. XVII. in English and Tamil.	H. Southern, B.A., Offg. Deputy Director of Agriculture, Madras.	Ditto.
51	Improvements in Paddy Cultivation recommended by the Department. Leaflet No. XVIII. in English, Tamil and Telugu.	R. Cecil Wood, B.A., Principal, Agricultural College, Coimbatore.	Ditto.
52	Cotton. Leaflet No. XIX. in English, Tamil and Telugu	Ditto.	Ditto.
53	Sugarcane in South Canara. Leaflet No. XX. in English and Canarese.	Ditto	Ditto
54	Sugarcane. Leaflet No. XXI. in English, Tamil and Telugu.	Ditto	Ditto.
55	Jaggery Making. Leaflet No. XXII. in English, Tamil, Telugu, Malayalam and Canarese.	M. R. Ry. P. Bal Krishna Menty	Ditto
56	Ginger Cultivation on the West Coast. Leaflet No. XXIII in English, Malayalam and Canarese.	M. R. Ry. M. Govind Kurup.	Ditto.
57	Report on the Working of the Department of Agriculture, Central Provinces, for the year 1910-11. Price Re. 1.	Department of Agriculture, Central Provinces	Central Provinces Secretariat Press, Nagpur
58	Report on the Agricultural Stations in the Central Provinces and Berar, for the year 1910-11. Price Re. 1	Ditto	Ditto
59	Report on the Management of the Provincial and District Gardens, Central Provinces, for the year 1910-11. Price 8 annas.	Ditto	Ditto
60	The Monthly Agricultural Gazette, August 1911 to January 1912. Price 2 annas per copy.	Department of Agriculture, Central Provinces, Nagpur	Ditto
61	Report on the Operations of the Department of Agriculture, Burma, for 1910-11. Price 6 annas or 7 pence.	H. Clayton, M.A., I.C.S., Director of Agriculture, Burma.	Government Printing, Burma, Rangoon.
62	Scientific Report of the Mandalay Agricultural Station, for the year 1910-11. Price 4 annas or 5 pence.	E. Thompstone, B.sc., Deputy Director of Agriculture, Burma, N. Circle.	Ditto
63	Rural Development in Burma. Price Re. 1.	H. Clayton, M.A., I.C.S., Director of Agriculture, Burma.	British Burma Press, Rangoon.
64	Two useful Rice Pounders used in the Shan States. Leaflet No. XXVIII.	Department of Agriculture, Burma	Government Printing, Burma, Rangoon.
65	Cultivation of the Castor Oil Plant. Leaflet No. XXIX.	Ditto.	Ditto.
66	List of Improvements recommended by the Department.	Ditto	Ditto
67	Report of the First Agricultural and Co-operative Conference, Burma, held from July 18th to 21st, 1911.	Ditto	Ditto.

LIST OF AGRICULTURAL PUBLICATIONS—*contd.*

No.	Title.	Author.	Where Published.
	General Agriculture—concluded.		
68	Annual Report of the Agricultural Department of E. B. and Assam for the year ending 30th June 1911. Price 8 annas.	Department of Agriculture, E. B. and Assam.	Government Secretariat Press, Shillong.
69	Annual Report of the Dacca Agricultural Station, for the year ending 30th June 1911.	Ditto.	Ditto.
70	Annual Report of the Burirhat Agricultural Station, for the year ending 30th June 1911.	Ditto.	Ditto.
71	Annual Report of the Rajshahi Agricultural Station, for the year ending 30th June 1911.	Ditto.	Ditto.
72	Annual Report of the Jorhat Agricultural Station, for the year ending 30th June 1911.	Ditto.	Ditto.
73	Annual Report of the Upper Shillong Agricultural Station, for the year ending 30th June 1911.	Ditto.	Ditto.
74	Annual Report of the Fruit Experimental Station, Shillong, for the year ending 30th June 1911.	Ditto.	Ditto.
75	Annual Report of the Tropical Plantation at Waltair, for the year ending 30th June 1911.	Ditto.	Ditto.
76	Central Seed Depot, Dacca Price List, 1911-12.	Ditto.	Ditto.
77	Annual Report of the Agricultural Stations in Eastern Bengal and Assam, for the year 1910-11. Price 12 Annas or 1 shilling.	Ditto.	Ditto.
78	Indian Tea Association Scientific Department, *Quarterly Journal*, Part IV, 1911.	Indian Tea Association ...	Catholic Orphan Press, Calcutta.
79	Green Manuring in Mysore. Bulletin No. 1. Price 0 8 0.	Mysore Department of Agriculture.	Government Press, Bangalore.
80	Soils. A paper read before the South Indian Association.	S. Narayan Swami Iyer, M.A.	Bangalore Daily Post, Ltd., Bangalore.
81	Report of the Sixth Indian Industrial Conference held at Allahabad on 30th December 1910. Price Rs. 2. Postage extra.	The General Secretary, Indian Industrial Conference, Amraoti, C. P.	Messrs. G. C. Loganadham Bros., Mount Road, Madras.
	Agricultural Chemistry.		
82	Records of Drainage in India. Memoirs of the Imperial Department of Agriculture. Chemical Series, Vol. II, No. 2. Price Re. 1.	J. Walter Leather, Ph.D., F.I.C., F.C.S., Imperial Agricultural Chemist.	Messrs. Thacker, Spink & Co., Calcutta.
83	Experiments at the Partabgarh Experimental Station, 1909-11. Bulletin No. 27 of the Agricultural Research Institute, Pusa. Price 5 annas or 6 pence.	G. Clarke, F.I.C.; H. E. Annett, B.Sc.; Syed Zamin Hussain, B.A., assisted by S. C. Banerji and Nath Hussain.	Government Printing, India, Calcutta.
84	Report on the Sugar Cultivation in the Mohnyin Valley, Katha District.	F. J. Warth, M.Sc., Agricultural Chemist, Burma.	Superintendent, Government Printing, Burma.
85	Report on the Source, Supply and Agricultural Value of Silt in Burma	Ditto.	Ditto.

LIST OF AGRICULTURAL PUBLICATIONS—*concluded.*

No.	Title	Author.	Where Published.
	Agricultural Chemistry—concluded.		
86	Sugarcane in Burma. Bulletin No. 6. Price 2 annas or 2 pence.	J. MacKenna, M.A., I.C.S., Director of Agriculture; and F. J. Warth, M.Sc., Agricultural Chemist, Burma.	Superintendent, Government Printing, Burma.
87	Note on the Available Manures in Burma.	F. J. Warth, M.Sc., Agricultural Chemist, Burma.	Ditto.
88	Principles of Paddy Manuring. Bulletin Vol. III, No. 63.	W. H. Harrison, M.Sc., Agricultural Chemist, Madras.	Government Press, Madras.
89	Paddy Manuring. Leaflet No. 24, in Tamil and Telugu.	Ditto.	Ditto.
	Mycology.		
90	Preliminary Study of the Red Rot of Sugarcane in the Bombay Presidency. Bulletin No. 44. Price 8 annas or 9 pence.	G. S. Kulkerni, B. Ag., Assistant Mycologist, Agricultural College, Poona.	Government Central Press, Bombay.
91	Two Years Experiments in the Treatment of Grape Vine Mildew in the Bombay Presidency. Bulletin No. 45. Price 14 annas or 1 shilling 4 pence.	W. Burns, B.Sc., Economic Botanist, Bombay Presidency.	Ditto.
	Botany.		
92	Studies in Indian Fibre Plants, No. 2, on some new varieties of Hibiscus Cannabinus L. and Hibiscus Sabdariffa L. Memoirs of the Imperial Department of Agriculture, Botanical Series, Vol. IV, No. 2. Price Rs. 3.	A. Howard, M.A., A.R.C.S., F.L.S., Imperial Economic Botanist, and Gabrielle L. C. Howard, M.A., Personal Assistant to the Imperial Economic Botanist.	Messrs. Thacker, Spink & Co., Calcutta.
93	Notes on the Incidence and Effect of Sterility and Cross fertilization in the Indian Cottons. Memoirs of the Imperial Department of Agriculture, Botanical Series, Vol. IV, No. 3. Price Re. 1.	H. M. Leake, M.A., F.L.S., Economic Botanist, U.P. and Ram Prasad, Assistant to the Economic Botanist.	Ditto.
94	The Cultivation of the Para Rubber Tree. Price 2 annas or 2 pence.	A. M. Sawyer, Assistant Botanist, Burma.	Government Printing, Burma, Rangoon.
	Entomology.		
95	Life Histories of Indian Insects, III. The Rhinoceros Beetle (Oryctes Rhinoceros) and the Red or Palm Weevil (Rhynchophorus ferrugineus). Memoirs of the Imperial Department of Agriculture, Entomological Series, Vol. II, No. 10. Price Rs. 2.	C. C. Ghosh, B.A., Assistant to the Imperial Entomologist.	Messrs. Thacker, Spink & Co., Calcutta.
96	The Food of Birds in India. Memoirs of the Imperial Department of Agriculture, Entomological Series, Vol. III. Price 7 rupees 8 annas.	C. W. Mason, late Supery. Entomologist.	Ditto.
97	Damage by Beetles in Tea Chest Woods. Price 6 annas.	G. D. Hope, Ph.D.; and C. B. Antram.	Catholic Orphan Press, Calcutta.

PUBLICATIONS OF THE IMPERIAL DEPARTMENT OF AGRICULTURE IN INDIA.

(TO BE HAD FROM MESSRS. THACKER, SPINK & CO., CALCUTTA.)

Annual Report of the Imperial Department of Agriculture in India for the year 1904-05. Price, As. 12 or 1s. 2d.

Report of the Imperial Department of Agriculture in India for the years 1905-06 and 1906-07. Price, As. 6 or 7d.

Report of the Agricultural Research Institute and College, Pusa (including Report of the Imperial Cotton Specialist) for the years 1907-08. Price, As. 4.

Report of the Agricultural Research Institute and College, Pusa (including Report of the Imperial Cotton Specialist) for the year 1909-10. Price, As. 4 or 5d.

Report of the Agricultural Research Institute and College, Pusa (including Report of the Imperial Cotton Specialist) for 1910-11. Price, As. 6 or 7d.

Report on the Progress of Agriculture in India for the years 1907-08. Price, As. 6 or 7d.

Report on the Progress of Agriculture in India for the year 1909-10. Price, As. 6 or 7d.

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